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ABSTRACT

Provided are transcripts of testimony presented at hearings on the status of mathematics/science education in the United States and testimony related to six bills to upgrade science/mathematics education, increase the supply of teachers, provide teacher training, and encourage training of students in high technology skills. These bills are H.R. 5742, 6656, 6674, 6775, 6950, and 7135. Testimony includes statements from representatives of government and industry, as well as science and mathematics educators concerned with the current crisis in science, mathematics, and technical education. Testimony focuses on all aspects of science/mathematics curriculum, instruction, teacher preparation and shortages, and other areas of concern. Prepared statements, letters, and supplemental material used during the hearings are provided in appendices. (JN)

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HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION
(Part 1)

JOINT HEARINGS

BEFORE THE

SUBCOMMITTEE ON ELEMENTARY, SECONDARY,
AND VOCATIONAL EDUCATION

AND THE

SUBCOMMITTEE ON POSTSECONDARY EDUCATION

OF THE

COMMITTEE ON EDUCATION AND LABOR
HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

SECOND SESSION

ON

H.R. 5742, H.R. 6656, H.R. 6674, H.R. 6775, H.R. 6950, and H.R. 7135

HEARINGS HELD IN WASHINGTON, D.C., ON SEPTEMBER 28, 29, AND 30, 1982

Printed for the use of the Committee on Education and Labor

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2

CONTENTS

Page

Hearings held in Washington, D.C., on:

September 28, 1982 1
September 29, 1982 181
September 30, 1982 281

Text of:

H.R. 5742 3
H.R. 6656 11
H.R. 6674 17
H.R. 6775 31
H.R. 6950 45
H.R. 7135 54

Statement of:

Boehm, Elmer, manager, engineering, Monsanto Co 220
Carl, Iris M., area 5 instructional supervisor, Houston Independent School District 302
Dodd, Hon. Christopher J., a U.S. Senator from the State of Connecticut 92
Evans, Daniel, president, Evergreen State College, State of Washington 131
Flowers, Anne, dean, School of Education, Georgia Southern College 224
Forbes, Roy H., director, National Assessment of Educational Progress, Education Commission of the States 147
Glenn, Hon. John, a U.S. Senator from the State of Ohio 183
Hart, Hon. Gary, a U.S. Senator from the State of Colorado 124
McCurdy, Hon. Dave, a Representative in Congress from the State of Oklahoma 196
McGuire, Willard H., president, National Education Association 108
Parent, M. Joan, first vice president, National School Boards Association, Foley, Minn 282
Petersen, Gary, chairman, manpower project, Electronic Industries Association and vice president, GTE Automatic Electric, Inc 150
Selby, Cecily Cannan, cochairman, National Science Board, Commission on Pre-College Education in Mathematics, Science, and Technology 118
Taylor, Paul, director, division of science, North Carolina State Department of Public Instruction 231
Thomson, Scott D., executive director, National Association of Secondary School Principals 203
Tirana, Bardyl, vice chairman, Technics, Inc., representing the California Commission on Industrial Innovation 309
Tucker, Alvin, director, Training and Education, Assistant Secretary for Defense (Manpower, Reserve Affairs, and Logistics), U.S. Department of Defense 207
Van Dorn, Bonnie, director, Association of Science and Technology Centers, appearing on behalf of the Exploratorium, San Francisco, Calif 331

Prepared statements, letters, supplemental material, etc.:

American Personnel & Guidance Association, prepared statement of 349
Boehm, Elmer, manager of engineering, Monsanto Co., prepared statement of 221
Carl, Iris M., area 5 instructional supervisor, Houston Independent School District:
    Achievement test scores for grades 1-6 305
    Achievement test scores for grades 7-12 305
    Five-year projection, step reduction (chart) 308
    1982-83 second mile plan components 306
Flowers, Dr. Anne, dean, School of Education, Georgia Southern College, Statesboro, Ga., prepared statement of 227

Prepared statements, letters, supplemental material, etc.—Continued

	Page
Forbes, Roy H., associate executive director for programs, Education Commission of the States, Denver, Colo., prepared statement of	135
Glenn, Hon. John, a U.S. Senator from the State of Ohio, prepared statement of	189
Hurd, Paul DeHart, emeritus, Stanford University, state of precollege education in mathematics and science	166
McCurdy, Hon. Dave, a Representative in Congress from the State of Oklahoma, prepared statement of	198
McGuire, Willard H., president, National Education Association, prepared statement of	100
National Council of Teachers of Mathematics, prepared statement of	253
Parent, Dr., M. Joan, first vice president, National School Boards Association, Foley, Minn.:	
Prepared statement on behalf of the	292
The National Education and Economic Development Act of 1982, the "Need" bill (H.R. 7135)	288
Petersen, Gary, chairman, Manpower project, Electronic Industries Association and vice president, GTE Automatic Electric, Inc., factsheet of Electronic Industries Association, 1982	151
Selby, Cecily Cannan, cochairman, National Science Board, Commission on Pre-College Education in Mathematics, Science, and Technology:	
Background of	111
Education Commission to explore improvement in science, math achievement, National Science Foundation news	112
Smith, Robert L., executive director, Council for American Private Education (CAPE), Washington, D.C., prepared statement of	348
Taylor, Paul H., director, division of science, Department of Public Instruction, Raleigh, N.C., prepared statement of	236
Thomson, Scott D., executive director, National Association of Secondary School principals, prepared statement of	205
Tirana, Bardyl, vice chairman, Technics Inc., representing the California Commission on Industrial Innovation:	
Prepared statement of	310
"Winning Technologies, a New Industrial Strategy for California and the Nation," a report entitled	311
Tucker, Alvin, Director of Training and Education, Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics), U.S. Department of Defense, prepared statement of	209
Turner, Walter G., executive director, American Association of Educational Service Agencies, Arlington, Va., letter to Chairman Perkins, with enclosure, dated November 3, 1982	350

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION

Part 1

TUESDAY, SEPTEMBER 28, 1982

House of Representatives, Subcommittee on Elementary, Secondary, and Vocational Education and Subcommittee on Postsecondary Education, Committee on Education and Labor,

Washington, D.C.

The subcommittee met, pursuant to notice, at 9:45 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the subcommittee) presiding.

Members present: Representatives Perkins, Miller, Kildee, Goodling, Erdahl, and Petri.

Staff present: John F. Jennings, counsel and Nancy Kober, legislative specialist.

Chairman **Perkins**. The subcommittee will come to order.

A quorum is present and we will begin.

This morning the Subcommittee on Elementary, Secondary, and Vocational Education is commencing what I believe will be some of the most important and productive hearings held by the subcommittee during the 97th Congress.

Today, tomorrow, and Thursday we will be examining the status of mathematics and science education in our Nation, particularly at the elementary and secondary level.

Through these hearings I hope to call attention to some serious issues confronting our schools and to initiate discussion of some possible solutions at all levels of government.

Our schools presently face a crisis in the areas of mathematics and science education. This crisis is evidenced by declines in standardized achievement test scores, by a drop in the number of students studying advanced mathematics and sciences, and by a shortage of teachers in these areas.

The situation is especially critical in light of the demands of new technology and our declining stature in the international market place.

This crisis is not unlike the state of affairs our country faced in the late 1950's when the Soviet's sputnik launch brought to a head concerns over the level of science and mathematics education.

At that time we enacted the National Defense Education Act of 1958. This legislation was extremely successful in instigating a new, vigorious curriculum of mathematics, science, and foreign languages and in training education personnel.

We have a number of bills pending before the committee to upgrade mathematics and science education, to increase the supply of teachers, to provide teacher training, and to encourage training of students in high technology skills.

I invite the witnesses during the next 3 days to comment on any of these proposals.

I introduced one of these bills, H.R. 6674, the American Defense Education Act. This bill would provide grants to school districts to assist them in improving instruction in mathematics, science, foreign languages, and technology.

I would like to commend the National Education Association for initially drafting this legislation. I am pleased to welcome NEA President Willard McGuire here today to testify on this measure. Let me mention that the NEA has been sponsoring legislation along this line for a long period of time.

[The texts of H.R. 5742, H.R. 6656, H.R. 6674, H.R. 6775, H.R. 6950, and H.R. 7135 follow:]

97TH CONGRESS
2D SESSION

H. R. 5742

To establish a National Commission on Science, Engineering, and Technology Education.

IN THE HOUSE OF REPRESENTATIVES

MARCH 4, 1982

Mr. SKELTON introduced the following bill; which was referred jointly to the Committees on Education and Labor and Armed Services

---

A BILL

To establish a National Commission on Science, Engineering, and Technology Education.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "National Commission on Science, Engineering, and Technology Education".

FINDINGS

SEC. 2. The Congress makes the following findings:

(1) The United States must meet the continuing need for technological advances in science and engi-

neering if it is to maintain economic security and a strong national defense.

(2) Approximately 1.4 million scientists and engineers will be needed to fill anticipated growth and replacement demands by 1990, however projections estimate personnel shortfalls in these areas over the next ten years.

(3) Shortages of trained technical personnel will have particularly serious implications for the national defense posture of the United States as modern military operations and hardware have become increasingly more sophisticated and reliant on high technology.

(4) Science, engineering, and technology education in the United States is threatened by a shortage of academic personnel and by inadequate and aging laboratory facilities.

(5) The Soviet Union graduates more than twice as many scientists and engineers as the United States, and almost five times as many engineering students. The United States ranks third behind the Soviet Union and Japan in a comparison of the total number of engineering graduates and in the number of engineering graduates relative to the size of the total population. A continuation of this situation threatens to compromise

the technological edge which ensures the economic well-being and national security of the United States.

(6) While the educational community, the private sector, and the government, have demonstrated interest in the emerging crisis in science, engineering, and technology education, there has been no coordinated national effort to study the status of such education in the United States, the impact of anticipated deficiencies on national defense needs and the economy, and to recommend remedial actions.

(7) The scope and complexity of the problem of meeting the demand for qualified technically-trained personnel in the private sector, government, the armed forces, and academia require that a national commission be formed to combine the efforts and resources of these groups in seeking a solution to the problem.

ESTABLISHMENT

SEC. 3. The President in conjunction with the majority leader of the Senate and the Speaker of the House shall within 120 days after the effective date of this Act establish a National Commission on Science, Engineering, and Technology Education (hereinafter in this Act referred to as the "Commission").

DUTIES OF COMMISSION

SEC. 4. The duties of the Commission are as follows:

(1) Bring together representatives of the private sector, the government, and the educational community for the purpose of taking testimony and receiving evidence about the problems confronting science, engineering, and technology education problems in the United States.

(2) Define the scope of science, engineering, and technology education problems in the United States.

(3) Evaluate the impact of these problems on national defense, industry, research, and academia.

(4) Formulate remedial actions which can be taken by or among the private sector, the government, and the educational community to resolve the problems.

(5) Evaluate the impact on military manpower needs in the areas of science and engineering.

MEMBERSHIP

SEC. 5. (a) NUMBER AND APPOINTMENT.—The Commission shall be composed of nine members as follows:

(1) Three individuals appointed by the Secretary of Commerce who are qualified to serve on such a Commission by virtue of their education, experience, or training.

(2) Three individuals appointed by the Secretary of Defense who are qualified to serve on such a Com-

mission by virtue of their training, education, or experience.

(3) Three individuals appointed by the Secretary of Education who are qualified to serve on such a Commission by virtue of their training, education, or experience.

A vacancy in the Commission shall be filled in the manner in which the original appointment was made.

(b) TERMS.—Members shall be appointed for the life of the Commission

(c) BASIC PAY.—Members of the Commission shall serve without pay, but shall receive per diem and travel expenses (subject to the provisions of chapter 57 of title 5, United States Code) for each day (including travel time) during which they are engaged in the actual performance of duties vested in the Commission.

(d) QUORUM.—Five members of the Commission shall constitute a quorum, but a lesser number may hold hearings.

(e) CHAIRMAN.—The Chairman of the Commission shall be elected by the members of the Commission.

(f) MEETINGS.—

(1) The Commission shall meet at the call of the Chairman or a majority of its members.

(2) Meetings of the Commission shall be conducted according to Roberts Rules of Order.

DIRECTOR AND STAFF OF COMMISSION; EXPERTS AND CONSULTANTS

SEC. 6. (a) DIRECTOR.—The Commission shall, without regard to section 5311(b) of title 5, United States Code, have a Director who shall be appointed by the Commission and who shall be paid at a rate not to exceed the maximum rate of basic pay payable for GS-18 of the General Schedule.

(b) STAFF.—Subject to such rules as may be prescribed by the Commission, without regard to section 5311(b) of title 5, United States Code, the Director may appoint and fix the pay of such personnel as the Commission considers appropriate.

(c) APPLICABILITY OF CERTAIN CIVIL SERVICE LAWS.—The Director and staff of the Commission shall be appointed subject to the provisions of title 5, United States Code, governing appointments in the competitive service, and shall be paid in accordance with the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates.

(d) EXPERTS AND CONSULTANTS.—Subject to such rules as may be prescribed by the Commission, the Director may procure temporary and intermittent services under section 3109(b) of title 5 of the United States Code.

(e) STAFF OF FEDERAL AGENCIES.—Upon request of the Commission, the head of any Federal agency is authorized to detail, on a reimbursable basis, any of the personnel of such agency to the Commission to assist the Commission in carrying out its duties under this Act.

POWERS OF COMMISSION

SEC. 7. (a) HEARINGS AND SESSIONS.—The Commission may, for the purpose of carrying out this Act, hold such hearings, sit and act at such times and places, take such testimony, and receive such evidence, as the Commission considers appropriate.

(b) POWERS OF MEMBERS AND AGENTS.—Any member or agent of the Commission may, if so authorized by the Commission, take any action which the Commission is authorized to take by this section.

(c) OBTAINING OFFICIAL DATA.—The Commission may secure directly from any department or agency of the United States information necessary to enable it to carry out this Act. Upon request of the Chairman of the Commission, the head of such department or agency shall furnish such information to the Commission.

(d) GIFTS.—The Commission may accept, use, and dispose of gifts or donations or services or property.

(e) MAILS.—The Commission may use the United States mails in the same manner and under the same conditions as other departments and agencies of the United States.

(f) ADMINISTRATIVE SUPPORT SERVICES.—The Administrator of General Services shall provide to the Commission on a reimbursable basis such administrative support services as the Commission may request.

REPORT

SEC. 8. The Commission may transmit to the President and to each House of the Congress such interim reports as it considers appropriate and shall transmit a preliminary report to the President and to each House of the Congress not later than eighteen months after the date the Commission is duly organized, and shall transmit a final report to the President and to each House of the Congress not later than thirty months after the date the Commission is duly organized. The final report shall contain a detailed statement of the findings and conclusions of the Commission, together with its recommendations for such legislation, and administrative actions as it considers appropriate.

TERMINATION

SEC. 9. The Commission shall cease to exist six months after the submission of the final report.

EFFECTIVE DATE

SEC. 10. This Act shall take effect October 1, 1982.

97TH CONGRESS
2D SESSION

H. R. 6656

To establish a program of Presidential teaching and research fellowships in mathematics and science and a Presidential precollege science and mathematics in-service teaching program, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

JUNE 22, 1982

Mr. WINN introduced the following bill; which was referred jointly to the Committees on Science and Technology and Education and Labor

---

A BILL

To establish a program of Presidential teaching and research fellowships in mathematics and science and a Presidential precollege science and mathematics in-service teaching program, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "National Science and Technology Revitalization Act of 1982".

FINDINGS AND PURPOSES

SEC. 2. The Congress finds that—

I

(1) many sectors of society, including business, industry, medicine, and government, have become reliant on high technology for conduct of their affairs;

(2) the Nation's security, economic strength, and defense capability depend to a continuously increasing extent upon the technical competence of its work force;

(3) our competitiveness in world trade is greatly dependent upon innovation to offset lower labor costs enjoyed by other nations producing goods for technical markets;

(4) to produce innovation in the increasingly complex marketplace will require workers that are highly trained in technical skills;

(5) present precollege education in the United States does not prepare students adequately in technical fields, particularly mathematics and the physical and biological sciences;

(6) in many cases precollege mathematics and science teachers lack sufficient preparation to teach their subjects effectively;

(7) industrial competition for skilled engineers and scientists hampers efforts by colleges and universities to attract and retain faculty members in these disciplines;

(8) the factors that induce engineers and scientists to abandon teaching in favor of industrial positions also influence students to forego graduate study, and this will result in continued serious shortages of qualified professors; and

(9) the instruments and related facilities needed for use in training new technical workers are often obsolete, worn out, or otherwise inadequate.

POLICY

SEC. 3. It shall be the policy of the United States to encourage excellence and international competitiveness in technology and the sciences; to stimulate renewed vigor in education in mathematics, engineering, and science; to promote effective basic research and manpower training in support of these objectives; and to ensure that Federal responsibilities toward meeting these ends are met.

PRESIDENTIAL TEACHING AND RESEARCH FELLOWSHIPS

SEC. 4. (a) There is hereby established a program of Presidential teaching and research fellowships to support and encourage promising new faculty in establishing careers in academic research and education.

(b) The fellowships shall be awarded to untenured university faculty in mathematics, engineering, and the physical and biological sciences at universities with established doctoral research programs. Recipients shall have received a doctoral degree within seven years prior to award of the fellowship.

(c) Fellowships shall consist of—

(1) a basic research support grant of $25,000 per year for five years; and

(2) an additional research support award of up to $75,000 per year for five years, of which the maximum Federal contribution shall be $25,000 and shall be contingent upon private and other non-Federal matching contributions of $2 for each Federal dollar contributed.

(d) The fellowship program shall be administered by the National Science Foundation. Presidential fellows shall be selected by the National Science Foundation, in consultation with the Director of the Office of Science and Technology Policy.

PRESIDENTIAL PRECOLLEGE SCIENCE AND MATHEMATICS INSERVICE TEACHING PROGRAM

SEC. 5. (a) There is hereby established a Presidential precollege science and mathematics inservice teaching program to provide assistance to the States in improving the understanding and skills of secondary school teachers of science and mathematics. To ensure that the program is responsive to the plans and intentions of the separate States, the Intergovernmental Science, Engineering [illegible] Technology Advisory Panel of the Office of Science and Technology

Policy shall provide coordination with appropriate State offices and shall develop a plan and guidelines for the program.

(b) Such plan shall provide—

(1) for stipends for eligible teachers of precollege science and mathematics selected by the State and local school authorities to participate in summer programs to improve instructional skills and knowledge of subject matter;

(2) for development and teaching of program curricula by university departments of mathematics or physical and biological sciences;

(3) that not more than one-half of the funds necessary for stipends shall be provided by the Federal Government;

(4) that Federal funds will be allocated, to the extent practicable, in proportion to the secondary school population of the individual States; and

(5) for grants for planning and implementing State programs to all States electing to participate.

(d) The precollege science and mathematics in-service teaching program shall be administered by the National Science Foundation.

AUTHORIZATION OF APPROPRIATIONS

SEC. 6. (a) There is hereby authorized to be appropriated for the Presidential teaching and research fellowships program the sum of $10,000,000 for the fiscal year ending on September 30, 1983, $20,000,000 for the fiscal year ending on September 30, 1984, $30,000,000 for the fiscal year ending on September 30, 1985, $40,000,000 for the fiscal year ending on September 30, 1986, and $50,000,000 for fiscal year ending on September 30, 1987.

(b) There is hereby authorized to be appropriated for the Presidential precollege science and mathematics in-service teaching program the sum of $5,000,000 for the fiscal year ending on September 30, 1983, $10,000,000 for the fiscal year ending on September 30, 1984, $30,000,000 for the fiscal year ending on September 30, 1985, and $55,000,000 for the fiscal year ending on September 30, 1986. Of these sums, grants to the States for planning, initiating, and administering their programs shall total no more than $5,000,000 in any fiscal year.

97TH CONGRESS
2D SESSION

H. R. 6674

To authorize a national program of improving the quality of education.

IN THE HOUSE OF REPRESENTATIVES

JUNE 23, 1982

Mr. PERKINS (for himself, Mr. PRITCHARD, Mr. LANTOS, and Mr. WIRTH) introduced the following bill; which was referred to the Committee on Education and Labor

---

A BILL

To authorize a national program of improving the quality of education.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "American Defense Education Act".

FINDINGS AND PURPOSES

SEC. 2. (a) The Congress finds that—

(1) it is in the national interest that local systems of elementary and secondary education, under local control, be maintained and operated in all of the States which provide a high quality of education and which

strive toward excellence in achievement by all students;

(2) even though the States and local communities have, and should retain, control over, and primary responsibility for, elementary and secondary education, the Federal Government has an interest in providing assistance to local educational agencies for programs which are important to our national defense and our national economy; and

(3) in order to increase the productivity of the Nation's economy and ensure an adequate number of high school graduates qualified to serve in the Nation's defense, it is necessary to improve the quality of instruction and levels of achievement in mathematics, the sciences, foreign languages, communication skills, and technology, and to improve guidance and counseling.

(b) It is therefore the purpose of this Act—

(1) to authorize a national program of incentives which would assist local educational agencies in improving the quality of instruction in the schools of the United States in the fields of mathematics, the sciences, the communication skills, foreign languages, and technology, and in improving guidance and counseling;

(2) to provide that all local educational agencies be eligible to participate in that program; and

(3) to provide that, in carrying out this program, the policies of the United States regarding equality of educational opportunity be reaffirmed and renewed.

LOCAL PROGRAMS TO IMPROVE PUBLIC EDUCATION

SEC. 3. (a) Any local educational agency in any State which desires to participate in the national program to improve education shall develop and carry out a program for the improvement of instruction and student achievement. Such program shall include—

(1) an assessment of instruction and student achievement in the schools of such agency; and

(2) specific plans for improving instruction and achievement in mathematics, the sciences, the communication skills, foreign languages, and technology, and for improving guidance and counseling in such schools.

(b) Each local educational agency which develops a local program pursuant to subsection (a) shall—

(1) as part of the assessment carried out pursuant to clause (1) of subsection (a), determine specific educational problems in the school district of such agency and develop a means of addressing those problems through expanded, improved, or new educational methods or practices;

(2) establish local, specific, objectively measurable goals which are to be achieved through the program

developed pursuant to subsection (a) and establish or select a local procedure for measuring, at least annually, the extent to which such goals are being achieved;

(3) develop such programs through a procedure which involves the active public participation of the administrators, teachers, parents, business and industry, and representatives from the community as a whole;

(4) provide for inservice training of teachers as a means of improving the quality of instruction; and

(5) make available to the public a written statement which describes—

(A) the assessment carried out pursuant to clause (1) of subsection (a),

(B) the educational problems determined pursuant to clause (1) of this subsection,

(C) the overall program developed and carried out under this section, and

(D) the goals and procedures required by clauses (2) and (3) of this subsection.

PAYMENTS

SEC. 4. (a) Each local educational agency which establishes a program to improve education under section 3 shall be eligible for a basic payment for each fiscal year during which it conducts such program. The amount of such basic payment shall be equal to 2 percent of the payment rate established under subsection (c), multiplied by the number of children in average daily attendance in the school district of the local educational agency.

(b) Each local educational agency which conducts a program to improve education under section 3 during any fiscal year and demonstrates that the program substantially achieves the goals established for such year pursuant to clause (2) of section 3(b) shall, in addition to the payment for which it is eligible under subsection (a) for the succeeding fiscal year, be eligible for an incentive payment equal to 2 percent of the payment rate established under subsection (c) for such succeeding fiscal year, multiplied by the number of children in average daily attendance in the school district of the local educational agency.

(c)(1) The payment rate for any local educational agency in any State for any fiscal year shall be equal to the average per pupil expenditure for that State, except that the payment rate for any local educational agency shall not be less than the average per pupil expenditure in the United States.

(2) For the purposes of paragraph (1), the term "average per pupil expenditure" in a State, or in the United States, shall be the aggregate current expenditures, during the second fiscal year preceding the fiscal year for which the computation is made (or if satisfactory data for that year are not available at the time of computation, then during the

most recent preceding fiscal year for which satisfactory data are available), of all local educational agencies in the State, or in the United States (which for the purposes of this subsection means the fifty States, and the District of Columbia), as the case may be, plus any direct current expenditures by the State for operation of such agencies (without regard to the source of funds from which either of such expenditures are made), divided by the aggregate number of children in average daily attendance to whom such agencies provided free public education during such preceding year.

(3) For the purposes of paragraph (2), the term "current expenditures" means expenditures for free public education, including expenditures for administration, instruction, attendance and health services, pupil transportation services, operation and maintenance of plant, fixed charges, and net expenditures to cover deficits for food services and student body activities, but not including expenditures for community services, capital outlay, and debt service.

(d)(1) Notwithstanding any other provision of this section, the amount which may be appropriated for any fiscal year for payments under this section may not exceed the product of the total number of children in average daily attendance in the schools of all the local educational agencies in the States, multiplied by $100.

(2) If the total amount appropriated in accordance with paragraph (1) is less than the sum of the amounts for which all local educational agencies are eligible under this section, the amount paid to each local educational agency shall be ratably reduced to the extent necessary to bring such payments within the limits of the amount so appropriated. If additional funds become available for making payments under this section for that year, such reduced amounts shall be increased on the same basis that they were reduced.

APPLICATIONS FOR PAYMENTS

SEC. 5. (a) Each local educational agency which desires to receive the payment for which it is eligible for any fiscal year under section 4(a) shall notify the Secretary of its intention to establish a program under section 3 and, at such time and in such form and manner as the Secretary may require, submit an application therefor. Such application shall contain assurances that—

(1) the local educational agency has developed and is carrying out a local program meeting the requirements of section 3;

(2) the local educational agency will maintain a level of per pupil expenditures during that fiscal year which is at least equal to that maintained during the preceding fiscal year;

(3) adequate procedures for public participation in the development of the local program have been established and used and that such procedures include provisions for filing complaints concerning the operation of the local program and the resolution of problems arising from such complaints;

(4) the local educational agency has established a local program of inservice training for teachers in the schools of such agency, which program shall provide an adequate level of training for all teachers in need thereof and shall be operated under that supervision of the teachers in such schools; and

(5) the local educational agency will comply with section 6, relating to services for children enrolled in private schools.

(b) Each local educational agency which desires to receive the payments for which it is eligible for any fiscal year under section 4(b) shall include in its application under subsection (a) for the succeeding year such evidence as may be necessary to show that it has met the requirements of section 4(b) for that year.

(c) The Secretary shall approve each application submitted for any fiscal year which meets the requirements of subsection (a) or subsection (b), as the case may be.

PARTICIPATION OF CHILDREN ENROLLED IN PRIVATE SCHOOLS

SEC. 6. (a) To the extent consistent with the number of children in the school district of the local educational agency who are enrolled in private elementary and secondary schools, such agency shall make provisions for including educational services and arrangements (such as dual enrollment, educational radio and television, and mobile educational services and equipment) in which such children can participate. Expenditures for educational services and arrangements pursuant to this section for children in private schools shall be equal (taking into account the number of children to be served and the educational needs of such children) to expenditures for children enrolled in the public schools of the local educational agency.

(b)(1) If a local educational agency is prohibited by law from providing for the participation in programs for children enrolled in private elementary and secondary schools as required by subsection (a), the Secretary shall waive such requirement, and shall arrange for the provision of services to such children through arrangements which shall be subject to the requirements of subsection (a).

(2) If the Secretary determines that a local educational agency has substantially failed to provide for the participation on an equitable basis of children enrolled in private elemen-

tary and secondary schools as required by subsection (a), he shall arrange for the provision of services to such children through arrangements which shall be subject to the requirements of subsection (a), upon which determination the provisions of subsection (a) shall be waived.

(3)(A) When the Secretary arranges for services pursuant to this subsection, he shall, after consultation with the appropriate public and private school officials, pay to the provider the cost of such services, including the administrative cost of arranging for such services, from the appropriate allocation or allocations under this Act.

(B) Pending final resolution of any investigation or complaint that could result in a determination under this subsection, the Secretary may withhold from the allocation of the affected local educational agency the amount he estimates would be necessary to pay the cost of such services.

(C) Any determination by the Secretary under this section shall continue in effect until the Secretary determines that there will no longer be any failure or inability on the part of the local educational agency to meet the requirements of subsection (a).

(4)(A) The Secretary shall not take any final action under this subsection until the State educational agency and local educational agency affected by such action have had an opportunity, for at least forty-five days after receiving written notice thereof, to submit written objections and to appear before the Secretary or his designee to show cause why such action should not be taken.

(B) If a State or local educational agency is dissatisfied with the Secretary's final action after a proceeding under subparagraph (A) of this paragraph, it may within sixty days after notice of such action, file with the United States court of appeals for the circuit in which such State is located a petition for review of that action. A copy of the petition shall be forthwith transmitted by the clerk of the court to the Secretary. The Secretary thereupon shall file in the court the record of the proceedings on which he based his action, as provided in section 2112 of title 28, United States Code.

(C) The findings of fact by the Secretary, if supported by substantial evidence, shall be conclusive; but the court, for good cause shown, may remand the case to the Secretary to take further evidence, and the Secretary may thereupon make new or modified findings of fact and may modify his previous action, and shall file in the court the record of the further proceedings. Such new or modified findings of fact shall likewise be conclusive if supported by substantial evidence.

(D) Upon the filing of a petition under subparagraph (B), the court shall have jurisdiction to affirm the action of the Secretary or to set it aside, in whole or in part. The judgment of the court shall be subject to review by the Supreme Court of the United States upon certiorari or certification as provided in section 1254 of title 28, United States Code.

ADMINISTRATION

SEC. 7. (a) The Secretary of Education shall be responsible for the administration of the program authorized by this Act.

(b) The Secretary shall pay to each local educational agency which has an application approved under section 5 any fiscal year the amount for which that agency is eligible for that fiscal year.

DEFINITIONS

SEC. 8. For the purposes of this Act—

(1) the term "local educational agency" means a public board of education or other public authority legally constituted within a State for either administrative control or direction of, or to perform a service function for, public, elementary or secondary schools in a city, county, township, school district, or other political subdivision of a State, or such combination of school districts or counties as are recognized in a State as an administrative agency for its public elementary and secondary schools;

(2) the term "State" means a State, the District of Columbia, Puerto Rico, Guam, American Samoa,

the Northern Marianas, the Trust Territory of the Pacific Islands, or the Virgin Islands; and

(3) the term "Secretary" means the Secretary of Education.

JOINT SURVEY AND REPORT BY THE SECRETARIES OF DEFENSE AND EDUCATION

SEC. 9. (a) The Secretary of Education shall conduct a survey of the levels of academic achievement of eighteen-year-old persons in the United States each year beginning in 1983 and continuing for the succeeding four years in order to determine the extent to which the need for qualified personnel in the armed services can be satisfied without remedial education. Furthermore, the Secretary of Defense shall conduct a study projecting the manpower training needs of the Armed Forces for the next four years. The Secretary of Education shall prepare in conjunction with the Secretary of Defense and local educational agencies an analysis of educational needs of the Department of Defense to assist in efficient manpower development.

(b) Not later than October 1 of each year during which the surveys are being conducted pursuant to subsection (a), the Secretary of Defense and the Secretary of Education shall submit a joint report of their findings from such survey to the Congress. Such report shall include—

(1) a statement of findings by the two Secretaries with respect to the results of such survey;

(2) an estimate of the number of persons surveyed who qualify for entry into the armed services without remedial education and the number who do not qualify by reason of failure in academic achievement;

(3) a statement regarding the extent to which the estimated number of qualified persons meets the estimated personnel needs of the armed services; and

(4) recommendations for improving the quality of instruction in secondary schools with a view toward raising levels of academic achievement among eighteen-year-old persons.

97TH CONGRESS
2D SESSION

H. R. 6775

To authorize an educational assistance program which will provide low cost loans to college students who pursue mathematics and science baccalaureate degrees and enter the precollege mathematics and science teaching profession, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

JULY 15, 1982

Mr. MCCURDY introduced the following bill; which was referred to the Committee on Education and Labor

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A BILL

To authorize an educational assistance program which will provide low cost loans to college students who pursue mathematics and science baccalaureate degrees and enter the precollege mathematics and science teaching profession, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Precollege Mathematics and Science Teacher Assistance Act".

STATEMENT OF FINDINGS

SEC. 2. The Congress finds that—

(1) there is a growing shortage of mathematics and science teachers in the Nation's elementary and secondary schools;

(2) it is in the national interest to strengthen mathematics and science programs in elementary and secondary schools to meet the increasing demands on the work force for high technology jobs in the future;

(3) it is in the national interest to encourage more citizens to pursue academic and professional careers in fields of high technology;

(4) from 1971–1980 there has been a 77 per centum decline in the number of secondary school mathematics teachers being trained, and a 65 per centum decline in science teachers;

(5) nationwide in 1981–1982 50 per centum of the mathematics and science teachers in classrooms were unqualified, and were teaching with emergency certificates;

(6) teacher salaries are 50 to 70 per centum less than industry salaries, and thus mathematics and science teachers are leaving the classroom for more financially rewarding work in industry and business;

(7) industry's increasing demand for engineers and other technology-related jobs will require a greater

proportion of the work force to possess a strong academic background in mathematics and science; and

(8) it is in the national security interest of the United States that the decline in mathematics and science literacy be reversed.

STUDENT LOAN PROGRAM AUTHORIZED

SEC. 3. Title IV of the Higher Education Act of 1965 is amended by redesignating part F as part G and by inserting after part E the following new part:

"PART F—DIRECT LOANS TO STUDENTS IN INSTITUTIONS OF HIGHER EDUCATION PREPARING TO BE PRECOLLEGE MATHEMATICS AND SCIENCE TEACHERS

"PROGRAM AUTHORIZED

"SEC. 471. (a) The Secretary shall carry out a program of establishing and maintaining funds at institutions of higher education for making low-interest loans to students who—

"(1) pursue courses of study in mathematics or science, or both, in such institutions leading to a baccalaureate degree, and

"(2) intend to enter the precollege mathematics and science teaching profession.

"(b)(1) There are authorized to be appropriated such sums as may be necessary for fiscal year 1984 and for each of the five succeeding fiscal years ending prior to October 1, 1988, to carry out the provisions of this part.

"(2) In addition there are hereby authorized to be appropriated such sums for fiscal year 1988 and each of the five succeeding fiscal years as may be necessary to enable students who have received loans for academic years ending prior to October 1, 1988, to continue or complete courses of study.

"(c) For the purpose of this part, the term 'eligible student' means a student who meets the requirements of section 474(b).

"PAYMENTS TO INSTITUTIONS OF HIGHER EDUCATION

"SEC. 472. (a) The Secretary shall make payments under this part for any fiscal year to each institution of higher education having an agreement under section 473 on the basis of the estimated needs of that institution for making student loans under this part taking into consideration—

"(1) the actual cost of attendance at that institution, and

"(2) the financial ability of eligible students at that institution to meet the cost of attendance.

"(b)(1) The Secretary shall make payments required by subsection (a) of this section in such installments as the Secretary determines—

"(A) will not result in unnecessary accumulations of capital in the student loan fund of the institution of higher education concerned,

"(B) reflects accurately the disbursement of funds for student loans under this part by the institution of higher education concerned, and

"(C) will best carry out the objectives of this part.

"(2) The initial payments for any academic year under subsection (a) shall be made not later than March 1 for the academic year following the year for which the payment is made. Subsequent installment payments in each such academic year shall be made promptly.

"(c) Any institution of higher education desiring to receive payments from the Secretary under this part shall enter into an agreement under section 473 and shall submit an application for such payments to the Secretary in accordance with the provisions of this part. The Secretary shall set dates before which such institutions must file applications under this section. Each such application shall contain such information as is necessary to assure the validity of estimated need for loan funds.

"AGREEMENTS WITH INSTITUTIONS OF HIGHER EDUCATION

"Sec. 473. (a) An agreement with any institution of higher education for the payment under this part shall—

"(1) provide for the establishment and maintenance of a student loan fund for the purposes of this part;

"(2) provide for the deposit in such fund of—

"(A) payments made under this part, and

"(B) any other earnings of the funds;

"(3) provide that such student loan fund shall be used only for—

"(A) loans to eligible students, in accordance with the provisions of this part,

"(B) administrative expenses, as provided in subsection (b),

"(C) distributions, if any, and

"(D) costs of litigation, and other collection costs, if any, required by the Secretary in connection with the collection of a loan from the fund or a charge assessed pursuant to regulations under section 474(c)(5);

"(4) provide that upon the beginning of the repayment period the note or evidence of obligation shall be assigned to the Secretary for collection unless the Secretary and the institution of higher education agree to a later date for such assignment; and

"(5) include such other provisions as may be necessary to protect the financial interest of the United

States and promote the purposes of this part as are agreed to by the Secretary and the institution.

"(b) An institution which has entered into an agreement under subsection (a) shall receive, for each fiscal year during which it makes student loans from a student loan fund established under such agreement, a payment in lieu of reimbursement for its expenses in administering its student loan program under this part during such year. Each such payment, at the option of the institution, shall be made in accordance with section 489 or shall be an amount equal to $30 per academic year for each eligible student enrolled in that institution who receives a loan under this part for that year. For the purpose of the preceding sentence, the reference to part E in such section shall be deemed to refer to part F.

"TERMS OF LOANS

"SEC. 474. (a)(1) Loans from any student loan fund established pursuant to an agreement under section 473, to any student by any institution shall, subject to such conditions, limitations, and requirements as the Secretary shall prescribe by regulation, be made on such terms and conditions as the institution may determine.

"(2) The amount of all loans for each student for each academic year made by institutions of higher education from loan funds established pursuant to agreements under this part may not exceed the actual cost of attending such an institution for that year minus the aggregate of—

"(A) any financial assistance received by the student borrower under parts A and C of this title, or any other provision of Federal law;

"(B) any scholarship, grant, and loan assistance received by the student borrower; and

"(C) the expected family contribution or in the case of an independent student the expected self-help contribution.

"(3) Determinations under paragraph (2) shall be made by the institution of higher education, in accordance with the provisions of subpart 1 of part A of this title.

"(b) A loan from a student loan fund assisted under this part may be made only to a student who—

"(1)(A) is in need of the amount of the loan to pursue a course of study at such institution to qualify as a precollege mathematics or science teacher, and (B) majors in mathematics or science, or both;

"(2) is capable, in the opinion of the institution, of maintaining good standing in such course of study;

"(3) has been accepted for enrollment as an undergraduate student in such institution, or, in the case of a student already in attendance at such institution, is in good standing;

"(4) is carrying at least one-half the normal academic workload, as determined by the institution; and

"(5) enters into the agreement required by subsection (c).

In any case in which a student has been determined to be eligible for a loan under the preceding sentence, and such student thereafter fails to maintain good standing, the eligibility of such student shall be suspended, and further payments to, or on behalf of, such student shall not be made until such student regains good standing.

"(c) Each student described in subsection (b) shall enter into an agreement with the institution of higher education under which the student will—

"(1) within one year after receiving certification as a teacher, or not later than three years after the completion of the course of study for which student loans were made under this part, whichever occurs later, teach for a period of not less than the number of years equal to the number of years in which the student received student loans under this part in an elementary or secondary school in any State as a mathematics or science teacher; and

"(2) repay in accordance with paragraph (1) of subsection (d) the full amount of principal and interest of a loan made under this part in the event that the conditions of clause (1) are not complied with, or repay in accordance with paragraph (1) of subsection (d) the per centum of the amount of principal and interest of the student loans which are not canceled in accordance with the schedule on the cancellation of student loans contained in section 475, as the case may be.

"(d)(1) Any agreement between an institution and a student for a loan from a student loan fund assisted under this part—

"(A) shall be evidenced by note or other written instrument which, except as provided in section 475, provides for repayment of the principal amount of the loan, together with interest thereon, over a period beginning nine months after the date on which the student ceases to carry, at an institution of higher education or a comparable institution outside the United States approved for this purpose by the Secretary, at least one-half the normal full-time academic workload, and ending at a date not more than four years after such date pursuant to regulations of the Secretary, except that such period may begin earlier than nine months after such date upon the request of the borrower;

"(B) shall include provision for a graduated repayment schedule with larger payments due later in the repayment period and shall include provision for acceleration of repayment of the whole, or any part, of such loan, at the option of the borrower;

"(C) may provide, in accordance with regulations of the Secretary, that during the repayment period of the loan, payments of principal and interest by the borrower with respect to all outstanding loans made to him from a student loan fund assisted under this part shall be at a rate equal to not less than $90 per month, except (i) that the Secretary may, subject to such regulations, permit a borrower to pay less than $90 per month for a period of not more than one year where necessary to avoid hardship to the borrower;

"(D) shall provide that the loan shall bear interest, on the unpaid balance of the loan, at the rate of 7 per centum per annum, except that no interest shall accrue prior to the beginning date of repayment determined under clause (A);

"(E) unless the borrower is a minor and the note or other evidence of obligation executed by him would not, under applicable law, create a binding obligation, shall provide that the loan shall be made without security and without endorsement;

"(F) shall provide that the liability to repay the loan shall be canceled upon the death of the borrower, or if he becomes permanently and totally disabled as determined in accordance with regulations of the Secretary; and

"(G) may, pursuant to regulations of the Secretary, provide for an assessment of a charge with respect to the loan for failure of the borrower (i) to pay all or part of an installment when it is due or (ii) to file timely and satisfactory evidence of an entitlement of the borrower to a cancellation benefit under this part.

"(2) The amount of any charge for assignment of the note or evidence of obligation shall not exceed in the case of a loan which is repayable in monthly installments $1 for the first month or part of a month by which such installment or evidence is late and $2 for each such month or part of a month thereafter. The Secretary may elect to add the amount of any such charge to the principal amount of the loan as of the first day after the day on which such installment or evidence was due, or to make the amount of the charge payable to the institution not later than the due date of the next installment after receipt by the borrower of notice of the assessment of the charge.

"(e) An agreement to make payments under this part shall include provisions designed to make loans from the student loan fund established pursuant to such agreement reasonably available (to the extent of the available funds in such fund) to all eligible students in such institutions in need thereof.

"(f) In determining, for purposes of clause (2) of subsection (a) of this section, with respect to a student who is a veteran (as that term is defined in section 101(2) of title 38, United States Code), an institution shall not take into account the income and assets of his parents.

"CANCELLATION OF LOANS FOR CERTAIN PUBLIC SERVICE

"SEC. 475. (a)(1) The per centum specified in subsection (b) of this section of the total amount of any loan made from a student loan fund assisted under this part shall be canceled for each complete year of service after the date of enactment of the Precollege Mathematics and Science Teacher Assistance Act by the borrower under circumstances described in paragraph (2).

"(2) Loans shall be canceled under paragraph (1) for service as a full-time science or mathematics teacher for service in an academic year in an elementary or secondary school.

"(b)(1) The per centum of a loan which shall be canceled under paragraph (1) of subsection (a) of this section in the case of service described in paragraph (2), at the rate of 25 per centum for each year of such service.

"(2) If a portion of a loan is canceled under this section for any year, the entire amount of interest on such loan which accrues for such year shall be canceled.

"(3) Nothing in this section shall be construed to authorize refunding any repayment of a loan.

"(4) For the purposes of this section, the term 'year' where applied to service as a teacher means academic year as defined by the Secretary.".

97TH CONGRESS
2D SESSION

H. R. 6950

To establish a national high-technology technician training program, utilizing the resources of the Nation's two-year community colleges to contribute to the economic strength of the United States by creating a pool of skilled technicians in strategic high-technology fields, to increase national productivity, to improve the competitiveness of the United States in international trade, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

AUGUST 5, 1982

Mr. WALGREN (for himself, Mrs. HECKLER, Mr. BROWN of California, Mr. ERTEL, Mr. DYMALLY, and Mr. McCURDY) introduced the following bill; which was referred jointly to the Committees on Education and Labor and Science and Technology

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A BILL

To establish a national high-technology technician training program, utilizing the resources of the Nation's two-year community colleges to contribute to the economic strength of the United States by creating a pool of skilled technicians in strategic high-technology fields, to increase national productivity, to improve the competitiveness of the United States in international trade, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National High-Technology Technician Training Act".

STATEMENT OF FINDINGS

SEC. 2. The Congress finds that—

(1) the United States has no national policy to stimulate the development of a pool of trained high-technology technicians needed for national self-sufficiency in strategic high-technology fields, for the improvement of productivity of the Nation's industries, for the strengthening of our industries in competitive international markets, and for the reindustrialization of declining industrial areas of the Nation;

(2) the United States has become increasingly dependent upon foreign producers for high-technology equipment needed in reindustrialization and economic renewal, reducing the capability of the United States to maintain the degree of national self-sufficiency essential to economic independence in strategic high-technology fields;

(3) industries of the United States are experiencing a decline of productivity and profitability largely due to outdated plant, equipment, and processes and imbalances between technological possibilities and investment in technologically skilled human resources to bring possibilities to reality;

(4) imbalances exist between the availability of technically trained workers and the needs of industries

for technicians to produce, operate, and service high-technology equipment, systems, and processes, while at the same time unemployed young adults do not have the technical competencies needed to fill these needs, and there is no promise of this condition being self-correcting;

(5) the Nation's work force is in need of continual upgrading in this era of rapidly changing technology to produce, operate, and service high-technology systems and processes to increase the productivity and profitability of industry and to enable the United States to reduce its dependency upon foreign producers in strategic high-technology fields;

(6) a large pool of adults, many of whom are employed in high-technology industries, have deficiencies in basic computation, communication, and problem-solving skills essential to the development of technical competencies required to be productive in high-technology fields or to continue their employment in increasingly complex technological work settings;

(7) the Nation's two-year community colleges have, in many areas, developed capabilities to provide competency-based training leading to an associate degree in high-technology fields and short-cycle retraining required to meet industry needs and to in-

crease the level of technical, computational, and communications skills of technicians in high-technology occupations;

(8) although several national training programs have existed, these various Acts have not prompted unified national action to address the preparation of technicians for high-technology occupations required by the industrial complex of the United States and required to increase the productivity of the Nation's work force;

(9) incentives are necessary to stimulate increased collaboration between community colleges and private sector industrial, commercial, and labor interests essential to the development of a pool of skilled high-technology technicians needed for economic renewal, industrial development, and reindustrialization of key economic areas of the Nation;

(10) the economic vitality of the Nation's industrial complex will be strengthened through the national high-technology technician training program by increasing the pool of skilled technicians possessing the competencies required to produce national self-sufficiency in high-technology fields, to increase national productivity, to improve the competitiveness of the

United States in international trade, and to enhance the economic renewal of the United States;

(11) the national high-technology technician training program will give men and women from all backgrounds opportunities to pursue training and education programs leading to an associate degree or otherwise to upgrade their competence consistent with present and future needs of high-technology industries in the United States; and

(12) the national defense readiness of the United States will be enhanced by a national high-technology technician training program designed to produce technicians in strategic high-technology fields and to increase national self-sufficiency in these fields.

PURPOSE

SEC. 3. It is the purpose of this Act to establish a national high-technology technician training program, with matching Federal and community industrial support, to—

(1) develop the competence needed to make the Nation self-sufficient in strategic high-technology fields, to increase the productivity of our Nation's industries, and to improve the competitiveness of the United States in international trade;

(2) prepare newly trained technicians and skilled craftsmen, retrain persons whose skills need updating,

and upgrade employed technicians to enable them to be productive in strategic new and emerging high-technology fields by using the training resources of the Nation's two-year community colleges; and

(3) provide industries in the United States with a highly skilled work force capable of producing, operating, and servicing the advanced technology needed to modernize the Nation's industrial complex and to revitalize the Nation's economy.

NATIONAL HIGH-TECHNOLOGY TECHNICIAN TRAINING PROGRAM

SEC. 4. (a) The Director of the National Science Foundation is authorized and directed, in accordance with the provisions of this Act, to carry out, on a pilot scale, a high-technology technician training program under which accredited community colleges, using matching Federal and community industrial support, will provide training in technical competencies in strategic high-technology fields. Such programs shall include emphasis on on-the-job training intermixed with technical occupational training and shall place special recruiting emphasis on attracting men and women to the program who are in need of upgrading, or who are unemployed, especially young adults, and persons who have recently completed high school or who left high school prior to graduation.

(b) Each selected community college participating in the national high-technology technician training program shall establish an associate degree training program in designated high-technology occupational fields pursuant to regulations for such program issued by the Director of the National Science Foundation in accordance with the provisions of this Act.

(c) The Director shall—

(1) determine the specific high-technology occupational fields in which technician training is needed to meet present and future technician requirements,

(2) identify economic areas with high-technology industries in need of technician training critical to the reindustrialization, economic renewal, or economic development of such areas (which shall be designated high-technology industrial development areas), and

(3) select accredited community colleges which have a demonstrated ability to offer competency-based occupational training consistent with designated high-technology technician needs, and which are located in economic areas with a high concentration of high-technology industries, to provide training as authorized by this Act.

(d) To assure that the national high-technology technician training program is consistent with the needs of high-technology industries, the Director shall appoint a fifteen member National Advisory Council on High-Technology Technician Training, which shall have the responsibility to advise the Director on the implementation of the program, to review the effectiveness of the program, and to report annually to the Director and the Congress on recommendations for improvement of the program (through amendments to this Act or otherwise). The Council shall include representatives of industry, labor, the community colleges, and economic development organizations.

(e) The Director shall prepare and submit to the Congress an annual report on the national high-technology technician training program, together with—

(1) an evaluation of the program;

(2) a determination of the feasibility of expanding the program; and

(3) such recommendations, including recommendations for legislation, as the Director deems necessary.

(f) In carrying out his duties under subsection (e) of this section, the Director shall consult, cooperate, and coordinate with the programs and policies of the Department of Commerce and other relevant Federal agencies such as the Departments of Labor, Education, and Defense.

DEFINITIONS

SEC. 5. For the purposes of this Act—

(1) the term "high technology" means, for example, the modernization, miniaturization, integration, and computerization of electronic, hydraulic, pneumatic, laser, nuclear, chemical, telecommunication, and other technological applications to enhance productivity in manufacturing, communication, transportation, commercial, and similar economic activity; and

(2) the term "community college" means a two-year postsecondary educational institution that has authority to award an associate degree and has the mission of offering comprehensive education and training services to meet the needs of a prescribed community, including a two-year junior college, technical college, or technical institute, but excluding a postsecondary educational institution that has as its primary mission offering baccalaureate degree programs even though it may also offer associate degree programs.

AUTHORIZATION OF APPROPRIATIONS

SEC. 6. There is authorized to be appropriated $5,000,000 for the fiscal year 1983 and $10,000,000 for each of the fiscal years 1984 and 1985 to carry out the provisions of this Act.

97TH CONGRESS
2D SESSION

H. R. 7135

To strengthen the security and the economic and cultural progress of the Nation through Federal assistance for improved student opportunities in mathematics, science, technology, and foreign languages in the elementary and secondary schools.

IN THE HOUSE OF REPRESENTATIVES

SEPTEMBER 16, 1982

Mr. PERKINS introduced the following bill; which was referred to the Committee on Education and Labor

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A BILL

To strengthen the security and the economic and cultural progress of the Nation through Federal assistance for improved student opportunities in mathematics, science, technology, and foreign languages in the elementary and secondary schools.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "National Education and Economic Development Act of 1982".

FINDINGS AND PURPOSES

SEC. 2. (a) The Congress finds that—

(1) the Nation's defense and economic well-being, including our competitiveness in world markets, is becoming increasingly reliant upon technology;

(2) the Nation's defense and the nature of work will require a citizenry which possesses general and highly specific skills in mathematics, science, technology, and foreign languages;

(3) the technological skills and knowledge required for our Nation's defense, the emerging workplace and the lifestyle of our society is dependent upon the opportunity which all elementary and secondary school students are provided to gain access to quality education programs;

(4) there has been a dramatic decline in student interest in mathematics, science, and foreign languages, a decline in academic standards set for those subjects, as well as a decline of academically qualified persons seeking to teach those subjects;

(5) the new technologies will produce new careers and can provide effective and efficient supplements to the educational process;

(6) State and local educational agencies have the primary responsibility to provide programs which meet the above-mentioned needs but lack the necessary financial resources to do so; and

(7) it is in the national interest to support the Nation's future development by immediately supporting State and local efforts to provide programs to expand and enhance the educational opportunities described herein for all students.

(b) It is the purpose of this Act to establish a national effort to provide elementary and secondary students with high quality programs in mathematics, science, technology, and foreign languages by strengthening the financial capacity of local educational agencies to plan, design, implement, and evaluate course offerings in such program areas, and by mobilizing a collaborative effort by all levels of government, the private sector, universities, and other appropriate institutions to identify emerging occupational needs, instructional innovations, exemplary programs, and other informational and resource activities which can assist local educational agencies in providing students with the education and skills appropriate for the technological age.

TITLE I—FUNDING

AUTHORIZATIONS OF APPROPRIATIONS

SEC. 101. There are authorized to be appropriated $1,000,000,000 for fiscal year 1984, $2,000,000,000 for fiscal year 1985, and such sums as may be necessary for each of the three succeeding fiscal years, for the purpose of carrying out this Act.

ALLOCATION OF FUNDS

SEC. 102. (a) From the sums appropriated pursuant to section 101 for any fiscal year, the Secretary shall reserve—

(1) not more than 10 per centum for conducting programs of national significance as authorized by sections 401 and 402; and

(2) 1 per centum for allocation (A) to Guam, the Virgin Islands, American Samoa, the Trust Territory of the Pacific Islands, and the Northern Mariana Islands in accordance with their respective needs, and (B) to the Secretary of the Interior under section 401(b).

(b)(1) From the funds remaining after making the reservations required in subsection (a), the Secretary shall allocate to each State which meets the requirements of section 403 an amount which bears the same ratio to that remainder as the number of children aged five to seventeen, inclusive, in that State bears to the number of such children in all States.

(2) For the purposes of this subsection, the term "States" means the fifty States, the District of Columbia, and Puerto Rico.

TITLE II—LOCAL SCHOOL DISTRICT PROGRAMS

ALLOCATION TO LOCAL EDUCATIONAL AGENCIES

SEC. 201. (a) From the sum allocated to any State for any fiscal year under section 102, the State educational agency shall pay each local educational agency which has filed a plan in accordance with section 302 an amount which bears the same ratio to that sum as the ratio of children aged five to seventeen, inclusive, in the school district of such local educational agency bears to the number of such children in the school districts of all local educational agencies in that State which meet those requirements.

(b) For purposes of subsection (a), the term "local educational agency" shall include any combination of such agencies who have agreed to operate a joint program which meets the requirements of this Act.

(c) Prior to determining the distribution of funds required by subsection (a), the State educational agency may reserve not more than 5 per centum for State programs and administration.

ELIGIBILITY OF LOCAL EDUCATIONAL AGENCIES

SEC. 202. (a) A local educational agency (or combination of such agencies) shall receive a grant under section 201 for any fiscal year if it has a comprehensive plan on file with the appropriate State educational agency. Such comprehensive plan may cover a period not to exceed three years and may be amended at any time by the local educational agency to describe changes in or additions to the activities originally set forth therein. The comprehensive plan and any amendment thereto shall contain such information and be in such form as prescribed by the Secretary in accordance with the provisions of paragraph (2)(A) of section 301(b).

(b) A local educational agency shall not be eligible to receive funds under this Act unless—

(1) the school board of such agency approves the comprehensive plan and certifies that any comments of the State educational agency with respect thereto were given due consideration, and

(2) the size and scope of the program contained in the comprehensive plan would involve a total expenditure in excess of $25,000 from Federal, State, and local resources.

CONTENTS OF LOCAL COMPREHENSIVE PLAN

SEC. 203. (a) The local educational agency comprehensive plan required by section 202 shall set forth—

(1) a statement of the needs, goals, and priorities of the school district (including student achievement levels) for expanding and improving program opportunities in mathematics, science, technology, and foreign languages;

(2) a description of the programs and activities planned for the expenditure of funds received under this Act;

(3) a description of the methods by which the school district will assess and evaluate programs and activities funded under this Act;

(4) a description of the means by which the school district intends to stay abreast of developments in curricula, instructional methods, technological advances, and emerging careers in mathematics, science, technology, and foreign languages;

(5) a description of the use the local school district intends to make of (A) the resources of the business community, universities, public agencies (such as libraries and museums), and the State educational agency, and (B) peer review by other local educational agencies and other outside consultants in the implementation and subsequent evaluation of the programs and activities contained in its comprehensive plan; and

(6) a description of the efforts made by the local school district to seek and utilize the assistance of outside organizations, agencies, and persons such as those listed in clause (5) in the development of its comprehensive plan.

(b) Such comprehensive plan shall also contain assurances that—

(1) the local educational agency will maintain a combined level of either per student expenditures or

aggregate expenditures from State and local resources which is not less than 90 per centum of the level of such combined fiscal effort, either per student or in the aggregate, in the second preceding fiscal year;

(2) the local educational agency will develop and operate its program in a manner consistent with the assurances required by clauses (1) through (8) of section 436(b) of the General Education Provisions Act;

(3) the programs and activities funded pursuant to section 204 will be implemented in a manner consistent with the comprehensive plan as approved by the local school board; and

(4) the local educational agency will provide services to children in nonpublic schools consistent with the requirements of section 205.

AUTHORIZED ACTIVITIES

SEC. 204. (a) Each local educational agency, pursuant to its comprehensive plan, shall use funds received under this Act for any one or more of the following programs and activities:

(1) the acquisition of technological equipment (including microcomputers and cable television) for instructional and related support activities;

(2) the acquisition, development, and use of educational software programs in mathematics, science, technology and foreign languages;

(3) the inservice training of teachers, support personnel, and other appropriate personnel in the use of technological hardware and software (including a knowledge of the expected educational outcomes to be derived therefrom);

(4) the inservice training of teachers, curriculum specialists, and other appropriate personnel for the purpose of upgrading and modernizing course content and instructional methods in mathematics, science, technology, foreign languages, and technology career awareness;

(5) the payment of bonuses, fees, and other suitable arrangements with employees or consultants for the purpose of attracting and retaining persons who are qualified to teach programs in mathematics, science, technology, and foreign languages;

(6) the establishment of cooperative programs with local businesses, universities, public agencies (such as libraries and museums) and other institutions and organizations to engage the use of equipment, software, personnel, and other services for the purposes of enriching, expanding and modernizing school district

course offerings and career awareness activities in mathematics, science, technology, and foreign languages;

(7) the development and implementation of informational activities to assist administrators and local school board members in the selection and evaluation of equipment, technology software, course content, instructional methods, and other activities and programs funded under this Act;

(8) the development and implementation of programs to promote student interest in mathematics, science, and foreign languages and to assess student achievement in such courses;

(9) the establishment of programs and activities, consistent with the purposes of this Act, designed for students with special needs such as those who are educationally disadvantaged, gifted and talented, handicapped, or who have limited English-speaking ability;

(10) the construction and minor remodeling of facilities to the extent necessary for the effective utilization of equipment or the implementation of programs under this Act; and

(11) the monitoring, planning, evaluation, and management of programs and activities funded under this Act.

PARTICIPATION OF CHILDREN ENROLLED IN PRIVATE SCHOOLS

SEC. 205. (a) To the extent consistent with the number of children in the school district of the local educational agency who are enrolled in private elementary and secondary schools, such agency shall make provision for including special educational services and arrangements (such as dual enrollment, educational radio and television, and mobile educational services and equipment) in which such children can participate and meeting the requirements of sections 203 and 204. Expenditures for educational services and arrangements pursuant to this section for children in private schools shall be equal (taking into account the number of children to be served and the needs of such children) to expenditures for children enrolled in the public schools of the local educational agency.

(b)(1) If a local educational agency is prohibited by law from providing for the participation in special programs of children enrolled in private elementary and secondary schools as required by subsection (a), the Secretary shall waive such requirement, and shall arrange for the provision of services to such children through arrangements which shall be subject to the requirements of subsection (a).

(2) If the Secretary determines that a local educational agency has substantially failed to provide for the participation

on an equitable basis of children enrolled in private elementary and secondary schools as required by subsection (a), he shall arrange for the provision of services to such children through arrangements which shall be subject to the requirements of subsection (a), upon which determination the provisions of subsection (a) shall be waived.

(3)(A) When the Secretary arranges for services pursuant to this subsection, he shall, after consultation with the appropriate public and private school officials, pay to the provider the cost of such services, including the administrative cost of arranging for such services, from the appropriate allocation or allocations under this Act.

(B) Pending final resolution of any investigation or complaint that could result in a determination under this subsection, the Secretary may withhold from the allocation of the affected State or local educational agency the amount he estimates would be necessary to pay the cost of such services.

(C) Any determination by the Secretary under this section shall continue in effect until the Secretary determines that there will no longer be any failure or inability on the part of the local educational agency to meet the requirements of subsection (a).

(4)(A) The Secretary shall not take any final action under this subsection until the State educational agency and local educational agency affected by such action have had an opportunity, for at least forty-five days after receiving written notice thereof, to submit written objections and to appear before the Secretary or his designee to show cause why such action should not be taken.

(B) If a State or local educational agency is dissatisfied with the Secretary's final action after a proceeding under subparagraph (A) of this paragraph, it may within sixty days after notice of such action, file with the United States court of appeals for the circuit in which such State is located a petition for review of that action. A copy of the petition shall be forthwith transmitted by the clerk of the court to the Secretary. The Secretary thereupon shall file in the court the record of the proceedings on which he based his action, as provided in section 2112 of title 28, United States Code.

(C) The findings of fact by the Secretary, if supported by substantial evidence, shall be conclusive; but the court, for good cause shown, may remand the case to the Secretary to take further evidence, and the Secretary may thereupon make new or modified findings of fact and may modify his previous action, and shall file in the court the record of the further proceedings. Such new or modified findings of fact shall likewise be conclusive if supported by substantial evidence.

(D) Upon the filing of a petition under subparagraph (B), the court shall have jurisdiction to affirm the action of the

Secretary or to set it aside, in whole or in part. The judgment of the court shall be subject to review by the Supreme Court of the United States upon certiorari or certification as provided in section 1254 of title 28, United States Code.

TITLE III—STATE PROGRAMS AND ADMINISTRATION

STATE PLAN

SEC. 301. (a) Any State desiring to receive funds under this Act for any fiscal year shall have on file with the Secretary a State plan submitted by the State educational agency.

(b) The State plan required by subsection (a) shall be in such form and contain such information as required by the Secretary and shall—

(1) describe programs and activities to be conducted by the State educational agency pursuant to section 304; and

(2) contain the assurances that the State educational agency will—

(A) provide the Secretary with such information, and in such form, as he requires to carry out his responsibilities under this Act;

(B) establish a process for the active and continuing consultation of the State advisory council established under section 305;

(C) maintain a combined level of either per pupil expenditures or aggregate expenditures from State and local resources which is not less than 90 per centum of the level of such combined fiscal effort, either per student or in the aggregate, in the second preceding fiscal year;

(D) conduct State programs funded under section 304 in a manner consistent with its State plan;

(E) not take into consideration payments under this Act in determining the eligibility of any local educational agency in the State for State aid, or the amount of State aid, with respect to free public education of children; and

(F) comply with all of the specific requirements of this Act.

(c) The plan filed by the State under subsection (a) shall be for a period not to exceed three fiscal years, and may be amended annually and at any other time by the State educational agency to describe changes in or additions to the contents of such plan.

STATE ADMINISTRATION OF LOCAL PROGRAMS

SEC. 302. (a) A State educational agency shall review and, when deemed necessary, comment upon any local plan (and any amendment thereto) filed under title II for the purposes of—

(1) determining whether any portion of the local plan is inconsistent with any Federal law or regulation, and

(2) proposing any improvement to the local plan.

(b)(1) Subject to paragraph (2), the State educational agency, within sixty days from the date that a local educational agency files a plan which meets the requirements of subsection (a)(1), shall make payment to such local educational agency in accordance with the provisions of section 201.

(2) In the event a State educational agency seeks to ensure that a local educational agency will give full consideration to any proposed improvement or other comment with respect to its local plan, such State educational agency may require a written certification by the local educational agency that such proposed improvement or other comment was fully considered, and, further, such State educational agency may withhold the rendering of payment or any portion thereof until not later than fifteen days after the date of the receipt of such certification. Such withholding procedure shall not occur unless the State educational agency presents the local educational agency with its proposed improvements and comments

within sixty days after such local educational agency files its local plan.

(c) A State educational agency shall monitor the activities of local educational agencies and require such recordkeeping as considered necessary by the Secretary to meet his fiscal audit and program evaluation responsibilities under this Act.

STATE RULEMAKING

SEC. 303. Nothing in this Act shall be deemed to authorize or prohibit a State educational agency from adopting rules, regulations, procedures, guidelines, criteria, or other requirements applicable to programs and projects assisted under this Act if they do not conflict with the provisions of this Act or with other applicable Federal law. The imposition of any State rule, policy, or data collection form relating to the administration and operation of programs funded by this Act (including those based on State interpretation of any Federal law, regulation, or guideline) shall be identified as a State imposed requirement.

STATE PROGRAMS

SEC. 304. (a) From the sums reserved pursuant to section 201(c), the State educational agency shall spend no less than 60 per centum thereof for any one or more of the following purposes:

(1) basic and applied research for the improvement of curriculum, curriculum materials, and teacher effectiveness in courses involving mathematics, science, technology, and foreign language programs;

(2) the evaluation of technological hardware and software, including the development of evaluation models for use by local educational agencies;

(3) experimental and pilot programs to test the effectiveness of curriculum innovations, new technologies in education, and coordination activities between local educational agencies and other organizations (including businesses and other public agencies);

(4) technical assistance programs for local educational agencies requesting advice in the preparation, implementation, or evaluation of local plans;

(5) programs to promote student interest in mathematics, science, technology, and foreign languages, including information on emerging occupations;

(6) programs to examine the relationship between (A) the needs of the market place for persons in mathematics, science, technology, and foreign languages and (B) the preparation of general, vocational, and college-bound students for (i) careers in these areas, or (ii) enrollment in community and junior colleges and universities in courses leading to such careers.

(7) programs to involve the resources of the business sector, community and junior colleges, universities, public agencies, local educational agencies (through peer review), and other outside consultants and other organizations, agencies, and persons to assist State and local educational officials to achieve the purposes of the activities funded pursuant to paragraphs (1) to (6); and

(8) the dissemination of the information and results of the activities funded pursuant to paragraphs (1) to (7).

(b) Funds available to State educational agencies under subsection (a) may be used for grants and contracts with local educational agencies, institutions of higher education, and other public and nonprofit private agencies and institutions.

STATE ADVISORY COUNCILS

SEC. 305. (a)(1) Any State which desires to receive payments under this Act for any fiscal year shall establish a State advisory council, which shall be appointed by the Governor or, in the case of States in which the members of the State board of education are elected (including election by the State legislature), by such board. Members of each State advisory council shall be appointed for terms of three years except that (A) in the case of initial members, one-third of the membership shall be appointed for terms of one year each and one-third shall be appointed for terms of two years each, and (B) appointments to fill vacancies shall be for such terms as remain unexpired.

(2) Each State advisory council shall have as a majority of its members persons who are not educators or administrators in the field of education and shall include as members one or more individuals who are—

(A) knowledgeable with respect to emerging careers in the State requiring specific skills and general knowledge of mathematics, science, technology, and foreign languages;

(B) knowledgeable with respect to innovations (including technological innovations) in teacher training, instructional methods, and curriculum development in mathematics, science, technology, and foreign languages;

(C) representative of local educational agencies,

(D) members of local school boards;

(E) representative of private schools;

(F) representative of community and junior colleges;

(G) representative of universities and colleges;

(H) classroom teachers in mathematics, science, and foreign languages;

(I) employees of agencies of State government and other individuals who are knowledgeable with respect to (i) future manpower needs, (ii) changes in the workplace environment, and (iii) the career and workplace preparedness of students with general, vocational, and academic backgrounds in mathematics, science, technology, and foreign languages;

(J) representative of those industries and businesses in the State which develop or market technological hardware and software which is, or can be, used in elementary and secondary education; and

(K) representative of those businesses, industries, and other public agencies (such as libraries and museums) who have or can operate collaborative educational programs with school systems in mathematics, science, technology, and foreign languages.

(b) The State council shall—

(1) advise the State educational agency in the development of the three-year State plan submitted under section 301;

(2) make recommendations to State and local officials to involve the resources of the business sector, community and junior colleges, universities, local educational agencies (through peer review) and other public agencies, organizations, and persons in the plan-

ning, implementation, and evaluation of programs and activities funded under this Act;

(3) review and make recommendations to the State educational agency with regard to any available State data regarding elementary and secondary education in mathematics, science, technology, and foreign languages including the following: (A) trends in student achievement test scores, (B) trends in student participation, (C) the qualifications, preparation, certification, and compensation of teachers, (D) trends in State and local educational priorities, and (E) student preparation for emerging careers and the workplace generally, as well as student preparation for the requirements of community and junior colleges and universities (including schools of education);

(4) review and make recommendations to the State regarding the administration and operation of this Act;

(5) make such other recommendations to the State educational agency as it deems necessary to improve, modify, or expand elementary and secondary programs in mathematics, science, technology, and foreign languages as well as the educational technology to supplement such programs; and

(6) transmit to the Secretary and the National Advisory Council created under section 402 an annual report which includes any findings and recommendations made under clauses (1) through (5) and any other pertinent information.

(c) Not less than ninety days prior to the beginning of any fiscal year in which a State desires to receive a grant under this Act, the State shall certify the establishment and membership of its State advisory council to the Secretary.

(d) Each State advisory council shall meet within thirty days after certification has been accepted by the Secretary and shall select a Chairman from among its membership. The time, place, and manner of meeting, as well as council operating procedures and staffing, shall be as provided by the rules of the State advisory council, except that such rules must provide for not less than one public meeting each year at which the public is given an opportunity to express views concerning the elementary and secondary education programs of the State in mathematics, science, technology, and foreign languages, as well as the educational technology which supplements those programs.

(e) From the funds reserved pursuant to section 201(c) the State educational agency in any fiscal year shall pay the State advisory council such sums as the council considers necessary to carry out its functions under this Act, except that such sum shall not exceed 20 per centum of the amount reserved under section 201(c).

(f) The expenditure of funds made available under subsection (e) is to be determined solely by the State advisory council for carrying out its functions under this Act, and may not be diverted or reprogrammed for any other purpose by any State board, agency, or individual. Each council shall designate an appropriate State agency or other public agency, eligible to receive funds under this Act, to act as its fiscal agent for purposes of disbursement, accounting, and auditing.

PAYMENTS FOR STATE ADMINISTRATION

SEC. 306. From the funds reserved pursuant to section 201(c), a State educational agency may use such sums as may be necessary to pay the expenses which it incurs in administering this Act, except that in any fiscal year such sums shall not exceed 20 per centum of the amount reserved under section 201(c) or $75,000, whichever is greater. If a State educational agency determines (and so notifies the Secretary) that the cost of administering this Act exceeds 20 per centum of such reserved amount but does not exceed $75,000, the Secretary shall, from the sums reserved under section 102(a)(1), pay to such agency an amount equal to the amount by which such cost exceeds 20 per centum of the amount reserved under section 201(c).

TITLE IV—PROGRAMS OF NATIONAL SIGNIFICANCE

SECRETARY'S PROGRAMS

SEC. 401. (a) From the sums reserved under section 102(a)(1), the Secretary is authorized to make grants to, and contracts with, institutions of higher education (and consortia thereof), regional laboratories and centers, State and local educational agencies, and other educational organizations and institutions for the purposes of—

(1) determining developments in those hardware technologies which may be applied for elementary and secondary classroom use;

(2) experimenting with and assessing the educational benefits of various technological hardware and software approaches, including their effects to enable students to be more knowledgeable about, and to better utilize, subject content;

(3) assessing national progress in elementary and secondary mathematics, science, technology, and foreign language programs by conducting studies which may include—

(A) trends in student achievement and student enrollment in programs;

(B) trends in teacher certification requirements, teacher compensation, teacher education and inservice programs, and the numbers of teachers entering the fields of science, mathematics, technology, and foreign languages; and

(C) trends in student preparation for the technological skills and academic knowledge required for (i) emerging careers and the technological workplace, and (ii) meeting the standards of community and junior colleges and institutions of higher education; and

(4) establishing exemplary and pilot programs and dissemination programs relating to (A) the application of educational technology in the classroom, (B) improving teacher preparation, (C) establishing coordination activities between local and State educational officials with other organizations, institutions, agencies, and other resource persons, and (D) such other innovative activities to improve elementary and secondary educational programs in mathematics, science, technology, and foreign languages.

(b) From the sums reserved under section 102(a)(2), the Secretary shall make payments to the Secretary of the Interior in the amounts considered necessary by the Secretary to meet the needs of Indian children on reservations served by elementary and secondary schools operated for Indian children by the Department of the Interior. Such payment shall be made pursuant to an agreement between the Secretary and the Secretary of the Interior containing such assurances and terms as the Secretary determines will best achieve the purposes of this Act. Such agreement shall contain (1) an assurance that payments made pursuant to this subsection will be used solely for programs and projects approved by the Secretary of the Interior which meet the applicable requirements of title II of this Act and that the Department of the Interior will comply in all other respects with the requirements of this Act, and (2) provision for carrying out the applicable requirements of title II.

(c) Beginning in fiscal year 1985, the Secretary shall make an annual report to the President and the Congress on—

(1) the state of educational technology;

(2) the state of elementary and secondary educational programs in mathematics, science, technology, and foreign languages;

(3) the administration and operation of this Act;

(4) the comments and recommendations received from the National Advisory Council established under section 402; and

(5) a description of the programs conducted under subsection (a) and any findings and recommendations which the Secretary derived therefrom.

NATIONAL ADVISORY COUNCIL ON EDUCATION AND TECHNOLOGY

SEC. 402. (a)(1) There is established a National Advisory Council on Education and Technology (hereinafter referred to as the "National Council"), which shall consist of twenty-seven members who shall be appointed by the President for terms of three years, except that (A) in the case of initial members, nine shall be appointed for terms of one year each and nine shall be appointed for terms of two years each, and (B) appointments to fill vacancies shall be only for such terms as remain unexpired.

(2) The National Council shall include persons—

(A) knowledgeable with respect to new occupations in the technologies;

(B) knowledgeable with respect to the application of new technologies in elementary and secondary education;

(C) representing the Department of Education;

(D) representing the National Science Foundation;

(E) representing the National Academy of Sciences;

(F) representing the Department of Labor;

(G) repesenting the Department of Defense;

(H) representing the Department of Commerce;

(I) representing local educational agencies;

(J) representing local school boards;

(K) representing State educational agencies;

(L) representing private schools;

(M) knowledgeable with respect to special applications of new technologies, including educational uses for students who are handicapped, educationally disadvantaged, and of limited English-speaking ability;

(N) representing institutions of higher education; including the schools of teacher education of such institutions;

(O) representing community and junior colleges;

(P) familiar with computer and other technology training programs in industry;

(Q) knowledgeable with respect to the influence which technologies, including various software approaches, have on student learning; and

(R) representative of the general public, who are not Federal employees, and who have significant knowledge of education technology, educational needs for technology, and any other major aspect of education and technology.

(b) The National Council shall have a chairman who shall be selected by the President. The National Council shall meet at the call of the Chairman, but not less than four times a year.

(c) The National Council shall—

(1) review and evaluate the administration and operation of this Act, including its effectiveness in assisting State and local educational agencies to (A) improve the educational attainment of students in mathematics, science, technology, and foreign languages, (B) provide occupational and career awareness programs in new technologies, and (C) develop cost-effective programs;

(2) identify emerging trends and needs in educational technology (including software programing), teacher preparation, incentives, and qualifications, which may improve elementary and secondary programs in mathematics, science, technology, and foreign languages;

(3) conduct such studies, evaluations, and programs and projects to make findings and recommendations relating to elementary and secondary mathematics, science, technology, and foreign language programs with respect to (A) student participation in such programs, (B) effective curriculum and instructional innovations for (i) elementary and secondary education programs, and (ii) teacher preservice and inservice programs, and (C) the coordination of information and resources by local educational agencies, State educational agencies, the business community, universities,

and other public and private institutions and organizations in the planning, implementation, and evaluation of such elementary and secondary programs;

(4) conduct such other activities as necessary to assess, promote, and strengthen the connection between education and the national interest in defense, productivity and the intellectual needs of the citizenry in mathematics, science, technology, and foreign languages; and

(5) advise the President, the Congress, and the Secretary through annual reports and other means as to its findings and activities (including the items contained in paragraphs (1) through (4)) and any recommendations to improve the administration and operation of this Act (including budget suggestions).

(c) From the sums reserved under section 102(a)(1), the Secretary shall allocate not less than $2,000,000 for the purposes of this section in any fiscal year.

FEDERAL ADMINISTRATION OF STATE PLANS

SEC. 403. (a) The Secretary shall review, and when considered necessary, comment upon any State plan filed under title III (and any amendment thereto) for the purpose of—

(1) determining whether any portion of the State plan is inconsistent with the requirements of section

301, or any other provision of this Act or applicable Federal law or regulation, and

(2) proposing any improvement to such State plan.

(b) For any fiscal year, the Secretary shall make payment pursuant to section 102(b) as soon as possible to any State whose plan is not inconsistent with the requirements set forth in subsection (a)(1).

TITLE V—GENERAL PROVISIONS

WITHHOLDING OF PAYMENTS

SEC. 501. (a) Whenever the Secretary, after reasonable notice to any State educational agency and an opportunity for a hearing on the record, finds that there has been a failure to comply substantially with any assurance required to be given or conditions required to be met under this Act, the Secretary shall notify such agency of such finding and that, beginning sixty days after the date of such notification, further payments will not be made to the State under this Act (or, in his discretion, that the State educational agency shall reduce or terminate further payments under this Act to specified local educational agencies or State agencies affected by the failure) until he is satisfied that there is no longer any such failure to comply. Until he is so satisfied, (1) no further payments shall be made to the State under the Act, (2) payments by the State educational agency under this Act shall be limited to agencies not affected by the failure, or (3) payments to particular agencies shall be reduced, as the case may be.

(b) Upon submission to a State of a notice under subsection (a) that the Secretary is withholding payments, the Secretary shall take such action as may be necessary to bring his action to the attention of the public within the State.

JUDICIAL REVIEW

SEC. 502. (a) If any State is dissatisfied with the Secretary's action under section 501, such State may, within sixty days after notice of such action, file with the United States court of appeals for the circuit in which such State is located a petition for review of that action. A copy of the petition shall be forthwith transmitted by the clerk of the court to the Secretary. The filing of such petition shall act to suspend any withholding of funds by the Secretary pending the judgment of the court and prior to a final action on any review of such judgment. The Secretary thereupon shall file in the court the record of the proceedings on which he based his action, as provided in section 2112 of title 28, United States Code.

(b) A State educational agency shall be presumed to have complied with this Act, but the findings of fact by the Secretary, if supported by the weight of evidence, may overcome such presumption. The court may remand the case to the Secretary to take further evidence, and the Secretary may thereupon make new or modified findings of fact and may modify his previous action, and shall file in court the record of the further proceedings.

(c) Upon the filing of such petition, the court shall have jurisdiction to affirm the action of the Secretary or to set it aside, in whole or in part. The judgment of the court shall be subject to review by the Supreme Court of the United States upon certiorari or certification as provided in section 1254 of title 28, United States Code.

APPLICATION OF OTHER LAWS

SEC. 503. (a) Except as otherwise provided in this section, the General Education Provisions Act shall apply to the programs established by this Act.

(b) Sections 434, 435, and 436 of the General Education Provisions Act (relating to "State educational agency monitoring and agency application") shall not apply to programs authorized under this Act except to the extent that (1) the assurances contained in section 436(b) are referenced for the purposes of section 203, and (2) they relate to fiscal control and fiscal accounting procedures (including the title to property acquired with Federal funds), and shall not be construed to authorize the Secretary to require any reports or take any actions not specifically authorized by this Act.

AVAILABILITY OF APPROPRIATIONS

SEC. 504. Notwithstanding any other provisions of law, unless expressly in limitation of this section, funds appropriated in any fiscal year to carry out activities under this Act shall become available for obligation on July 1 of such fiscal year and shall remain available for obligation until the end of the succeeding fiscal year.

DEFINITIONS

SEC. 505. Except as otherwise provided herein, as used in this Act—

(1) the term "construction" includes the preparation of drawings and specifications for school facilities; erecting, building, acquiring, altering, remodeling, improving, or extending school facilities; and the inspection and supervision of the construction of school facilities;

(2) the term "elementary school" means a day or residential school which provides elementary education, as determined under State law, and the term "secondary school" means a day or residential school which provides secondary education, as determined under State law, except that it does not include any education provided beyond grade twelve;

(3) the term "equipment" includes machinery, utilities, and building equipment and any necessary enclosure or structures to house them, and includes all other items necessary for the functioning of a particular facility as a facility for the provision of educational

services, including items such as instructional equipment and necessary furniture, printed, published, and audio-visual instructional materials, and books, periodicals, documents, and other related materials;

(4) the term "free public education" means education which is provided at public expense, under public supervision and direction, and without tuition charge, and which is provided as elementary or secondary school education in the applicable State, except that such term does not include any education provided beyond grade twelve;

(5) the term "local educational agency" means a public board of education or other public authority legally constituted within a State for either administrative control or direction of, or to perform a service function for, public elementary and secondary schools in a city, county, township, school district, or other political subdivision of a State, or such combination of school districts or counties as are recognized in a State as an administrative agency for its public elementary or secondary schools, and such term includes any other public institution or agency having administrative control and direction of a public elementary or secondary school;

(6) the term "school facilities" means classrooms and related facilities (including initial equipment) for free public education and interests in land (including site, grading, and improvements) on which such facilities are constructed, except that such term does not include those gymnasiums and similar facilities intended primarily for exhibitions for which admission is to be charged to the general public;

(7) the term "Secretary" means the Secretary of Education;

(8) the term "State" means a State, District of Columbia, Puerto Rico, Guam, the American Samoa, the Virgin Islands, the Northern Mariana Islands, or the Trust Territory of the Pacific Islands; and

(9) the term "State educational agency" means the officer or agency primarily responsible for the State supervision of public elementary and secondary schools.

Chairman **Perkins**. We have several witnesses this morning on a panel.

We have the Honorable Gary Hart, U.S. Senator from the State of Colorado; the Honorable Christopher Dodd, U.S. Senator from the State of Connecticut; and Mr. Willard McGuire, president, National Education Association.

We also have Dr. Cecily Cannan Selby, cochairman, National Science Board Commission on Pre-College Education in Mathematics, Science, and Technology; Dr. Roy Forbes, director, National Assessment of Educational Progress, Education Commission of the States, Denver, Colo.; and Mr. Gary Petersen, chairman, Manpower Project, Electronic Industries Association, and vice president of GTE Automatic Electric, Inc.

I would like to call first on Congressman Miller for any opening remarks he may have.

Mr. **Miller**. Thank you, Mr. Chairman.

I commend the Chairman for undertaking these hearings and dedicating sufficient time for a thorough review of the Nation's deficit in precollege mathematics, science, and I might add, technology education.

During a period in which technological change is radically transforming the Nation's economy it is reprehensible that a majority of our students will graduate from high school with little understanding of mathematics, science, and technology.

As the pace of technological change quickens, an understanding of science and technology will become increasingly important in a wide range of pursuits which previously had no technical content.

The employment opportunities for the scientific and technically illiterate will continue to narrow.

If this decline is allowed to continue there could be ominous effects on the economy. President Reagan warns of severe negative consequences for our national productivity and describes the problem as "serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international marketplaces."

This is not the first time the country has faced a crisis in mathematics, science, and technical education. The launching of Sputnik, in late 1957, focused unprecedented attention on the small proportion of high school students enrolled in science and mathematics courses, the shortage of well-qualified teachers, and the need for scientific-oriented vocational education.

In response to the "sputnik shock," this committee and the Congress passed the National Defense Education Act. For over 10 years we invested in our children's education.

According to Secretary of Education T. H. Bell this investment "by all accounts accomplished its goal."

I was a beneficiary of this investment, as I am sure were other members of this committee. The product of this commitment is the Nation's leadership in technological development.

It is the students of the sputnik era who are developing many of the new technologies which offer such bright prospects for job growth and a strengthened economy.

What about the students of today? They deserve the same commitment. We must continue to plant seed. No matter how bright the sputnik generation, we are a deteriorating resource.

Thank you, Mr. Chairman.

Chairman. PERKINS. Thank you.

I would like all of our witnesses to come forward and sit around the witness table.

Senator Dodd will be our first witness this morning.

We welcome you here today.

You may proceed.

STATEMENT OF HON. CHRISTOPHER J. DODD, A U.S. SENATOR FROM THE STATE OF CONNECTICUT

Senator DODD. Thank you very much, Mr. Chairman.

It is a pleasure to be back home on the House side and back with you.

Mr. Chairman and members of the subcommittee, I appreciate the opportunity to testify on the state of science and mathematics education in the United States.

I know I express the sentiments of the cosponsors of this piece of legislation that I have introduced in the Senate. I am sure many others will appreciate these hearings as well.

Your recognition is always of importance to education problems and to what we might do to address some of them. Obviously science and math are the most serious areas.

I do not come in the guise of either a scientist or a mathematician. I cannot tell the difference between DNA and LSD. What I know about particle physics would not fill a quark.

In fact, I am told that a quark is either an infinitesimal particle that has space or an infinitesimal particle that does not have any space.

My mathematical ability does not extend beyond being able to count delegates or votes—even there, not always as well as I would like.

However, in the U.S. Senate I represent a State already critically dependent on high-technology industries and one whose economic future clearly lies more and more in that direction.

Since I was first elected to the House, Connecticut's high-technology firms have added more than 30,000 jobs to the State's economy.

Employment in those industries is growing four times as fast as in the State economy as a whole. These are the high technology positions.

I also represent a State of outstanding educational institutions, whose colleges and universities last year, ironically, produced only one graduate who could meet the State certification requirements for teaching high school physics.

That does not mean that we did not produce scientists and mathematicians. But of those who would seek certification to be able to teach physics in our public school systems, only one qualified, despite the fact that we take pride in being one of the leaders in the Nation in producing high-technology equipment.

We have run into that great contradiction.

That disturbing juxtaposition—a future that will need increasing numbers of trained scientists and technicians and an educational system that maybe losing its ability to produce the[illegible]—is the reason I am here this morning.

In fact, there is nothing unusual about Connecticut's situation in this regard.

One study concluded this year revealed that 42 States have a shortage of physics teachers, 43 have a shortage of mathematics teachers; and 38 have a shortage of chemistry teachers.

Another study conducted by the National Science Teachers Association, (NSTA) declares that 50.2 percent of the Nation's newly hired secondary science and mathematics teachers are unqualified to teach science.

Many teachers are currently employed on an emergency basis because qualified teachers are simply not available. It is the English teacher or person trained to teach English or history that is being recruited to come in and teach a science course or a math course.

They have virtually no background at all and yet are being plugged into classrooms and are expected to produce students that at least have a fundamental knowledge and hopefully some that might go on to advanced studies in these areas. The teachers just do not have the science or math background.

In addition, NSTA has determined that fewer students are entering the science and mathematics teaching fields. To make matters worse, one in four of the younger faculty members plans to leave teaching completely.

The decline in the number of qualified secondary school faculty members could not be more ill timed.

Many of the Nation's high-technology industries have expressed concern about filling both present and future vacancies. The New York Times featured an employment outlook in high technology in its March 28 edition. It projects 685,000 new jobs through 1990 for people trained in computer technology.

The introduction and increasing use of CAT scanners, ultrasound, nuclear scans, and fiberoptic instruments will mean more and more new technical jobs in medicine.

And yet, if we do not concentrate on improving science and mathematics education in our secondary schools, it is unlikely that we will be able to take advantage of these opportunities.

Former President Truman displayed his characteristic commonsense when he said that no nation can maintain its leadership unless scientific and technological resources are developed to the fullest, and the work of science in universities, industries, and its own labs receives generous and intelligent support.

It should be of some considerable concern that, while science and mathematics education in the United States may be in danger, other industrialized nations are putting more emphasis on these subjects.

The Soviet Union, for example, most experts agree, places more emphasis on science and mathematics at all levels of education than does the United States.

One result of this intense training can be clearly seen in the number of Soviet scientists with advanced engineering degrees.

A study prepared by the National Science Board reveals that 53 percent of graduating students in the Soviet Union received degrees in science and engineering fields, compared to about 18 percent in the United States.

The increased emphasis on science and mathematics education by Japan and West Germany certainly contributes to the rapid growth rate in the manufacturing productivity of these countries, at whose door we can lay much of our lagging competitive position in world trade.

There is no single key that I know which will unlock these problems. Obviously we should give our attention to a broad range of public policies which encourage basic research, along with practical application and development, and which provide incentives for guiding science and technology to useful public purposes.

But, I am convinced that effort, however well designed, will be wasted unless our educational system produces a pool of graduates with the interest and training to create and manage the science of the future.

Right now, the most formidable obstacle to the establishment of that pool is the inadequacy of our science and mathematics teaching resources at the secondary level.

A partial answer to that aspect of the problem is S. 2909 which I have introduced along with 15 of my colleagues, and H.R. 7100 introduced by Congressmen Dymally and Moffett.

Its centerpiece is a program of workshops and other measures, financed by grants, at which college and university personnel can help upgrade the competency, substantive knowledge, communication skills, and teaching strategies of secondary school science and mathematics teachers.

Its premise that better teachers are both more likely to attract and motivate potential future scientists, and more able to provide them the training they need, both for higher education and the requirements of tomorrow's economy.

It is not the whole answer, obviously.

But it is a beginning and will provide, at least, I think some short-term answers while we try to deal with the much more difficult long-term gaps that are growing in this area.

It is going to be vital for our own economic well-being, and for our national security interests.

Again, I want to compliment you and the committee for holding these three days of hearings on a most timely subject. It is possible that we are already too late.

But hopefully our recognition of it now can help us catch up and make the difference in the next several years.

I thank you for your patience and time.

Chairman **Perkins**. Thank you, Senator Dodd.

Senator Dodd, do you have to leave or can you stay for awhile?

Senator **Dodd**. I am always ready to give you a few minutes.

Chairman **Perkins**. I am interested in any suggestions you may have for alleviating the teacher shortages in the area of science and mathematics.

How can we attract good teachers and keep good teachers when teacher salaries are stagnating, due to budget cutbacks across the board?

And especially at the same time industry is offering higher salaries. What are your views there?

Senator **Dodd**. Mr. Chairman, the first argument is that if you do train them they will be snapped up by headhunters. You get a good qualified young person with knowledge of math or science and he or she will be gone.

I disagree with that premise. I represent, as part of my State, the submarine base in Groton, Conn. We have within view of that General Dynamics's Division of Electric Boat. We have the Northeast Utilities, which is a major nuclear powerplant down the road.

United Technologies Corp., AVCO, Union Carbide, GE, GTE, Xerox, IBM, and Champion have major corporate headquarters in the State of Connecticut.

They go and try to recruit young men and women who are officers in the submarine corps and who have achieved advanced degrees in science and mathematics.

What they discover is that, in many cases, they are successful, but in many they are not because these people are highly motivated and believe very much in what they are doing.

Although they are getting paid far less than what they are being offered by the private sector, they stay because there is motivation to be a part of something they feel is larger than the immediate gains of a private sector life.

I think that over the years teachers' salaries have been low. They have always been lower than what people could make in the private sector.

There is an assumption which is becoming rather crass to assume that people are just going to go to the job that pays the most money.

People who enjoy the teaching profession are more than aware that they could be making more money in many instances by going into the private sector, but they teach because they believe in it and they like doing it and they get that sense of satisfaction out of a teaching experience.

So I do not believe that the worry is really whether or not they are going to be bought out by the private sector. The question is motivating people and maybe providing, as Senator Glenn has suggested, some assistance in their higher education; that is, in getting them, and make it at least attractive for them to pursue science or math as a course of study.

So, I am not worried that we are going to lose people. I think the immediate problem is: How do we impress upon people the importance of choosing mathematics and science as a field of study?

If they are going to be teachers, that is the first inclination. The second, of course, is the subject area they have an interest and ability in.

I would be less concerned about losing them to the private sector, given the fact that they historically have had lower salaries than other people and that we underestimate the importance of motivation, which always has existed among the teacher corps in this country, whether in Kentucky or Connecticut.

Chairman **Perkins**. Mr. Miller?

Mr. **Miller**. Thank you, Mr. Chairman.

I think our two States are somewhat similar in that we received a report last summer about what happened in our famed Silicon Valley where apparently the private sector and the educational establishments simply passed in the night.

We now find those industries going elsewhere for skilled individuals because the school systems simply failed to provide the kind of education that the employers in that area needed.

I think that Connecticut has seen a similar situation.

Now we find that has caught our attention and now we lack the resources to prepare even those students who still remain in school.

I think you are drawing a focus on a terribly important issue. One, I think you are quite correct that we are going to have to make a concerted effort to train these people in skills and to pass on the elements of science and mathematics.

We are also going to have to decide that they, too, are professionals and that they are going to be treated as such and that they are going to be treated as a very important element in terms of our struggle in an economic sense to survive.

We obviously recognize that it was related to military after sputnik. Maybe we ought to decide, in the remainder of this decade and the next, that there is the question of economic survival if we are going to have skilled individuals out there.

I think it is very important that you have drawn this kind of attention to this problem.

I am concerned, however, that after 6 years in the House of Representatives that you were not able to tell the difference between DNA and LSD. [Laughter.]

I am concerned that the Senate does not have any experts over there on that subject.

Senator DODD. They do not know what DNA is over there. [Laughter.]

Mr. MILLER. I look forward to the testimony of the rest of the panel of witnesses on this subject. I am familiar with some of the individuals.

Let me ask you this, Senator.

In an effort for this retraining and in trying to find a full complement, certainly there are talented people out there in the private sector, either who have left the school systems of the country to seek different employment or gainful employment, and individuals who have not rubbed elbows with our school systems.

I wonder whether or not we could at least consider for discussion some expansion of this legislation in an effort to try to get those people to participate.

There are industries, at least in California, who loan individuals to the school systems to provide specialized expertise, whether for a month, a week, or whatever, to try to bring students current.

One of the problems we find is that you have a lag. You train the teacher and then you have the field up to date. In terms of movement, it is not there.

I wonder if you have considered that?

Senator DODD. That is an excellent suggestion. This is not written in concrete or marble at all.

In fact, we already have many of our higher education institutions in the State, particularly the University of Connecticut—and I presume it is going around the country—who already have ongoing relationships with the private sector. Sometimes it is in programs to upgrade and to train their own personnel to work for the private sector, in other cases to provide assistance financially to labs and so forth, particularly in the science fields.

They are the beneficiary, obviously, of some research that is done, but they also support that research.

I think this would make eminently good sense to have this kind of programing include people from the private sector.

So, when the grant applications come in as to who will do the teaching and the training and the kind of support that comes from the private sector, it would probably not only be good politics but make good sense in terms of the resources available, particularly in States like California or Connecticut, to make use of this tremendous resource.

There are 30,000 new high technology jobs in the last 8 years in Connecticut. We produced not one certified science or math teacher last year in the entire State of Connecticut.

That is the crux of the problem. We have the people out there. I think you have an excellent suggestion.

Mr. MILLER. Thank you.

Thank you, Mr. Chairman.

Chairman PERKINS. Mr. Erdahl?

Mr. ERDAHL. Thank you, Mr. Chairman.

I apologize to the Senator for being late. Mr. Goodling and I were at a briefing by the CIA as to what happened in China at their conference.

I read your statement. One of the things that seems obvious—and maybe the other panel members will discuss this later—but without being crass about it, one of the things we are going to have to, whether it is at Federal, State, or local level, is to give the incentive and adequate compensation if we are going to attract, keep, and retain competent teachers in these technical areas and not lose them either initially or eventually to industry.

Senator DODD. The chairman brought up that point. It obviously is a most crucial one in many ways. People sitting to my right and left here are far more competent to talk about this than I am.

But in my own family, my father had three sisters who taught for 35 to 40 years each in the public school system of Connecticut. There was 115 years of teaching experience in the State.

Two of them were Fulbright scholars and taught high school French, German, and remedial reading for years. All three of them easily could have been employed in the private sector in a number of sectors. They are that bright.

They happened to love teaching. My guess is that whatever the subject matter, they would have taught.

If they had to teach math, they would have learned math in order to do it.

I was mentioning earlier that we have young submariners in Connecticut who are constantly being recruited by the private sector. They do not go.

They are not making anywhere near the salaries they could get at United Technologies or General Dynamics as submariners, but they stay because they believe in it.

I think we underestimate the motivation which drives people to teaching.

So while I am concerned about people being weaned away because of the attractiveness of the financial opportunities at the private sector level, I do not think that problem is that severe given the historical difference that has existed between the salaries we pay teachers and the salaries that are received by those with comparable knowledge or background or degrees.

Again, I will leave that to the professionals to comment on, but I think we do disservice to the people in the teaching profession to assume that that is the motivation for their teaching, that is, to make money, and that they ought to have their heads examined.

That motivation has existed as long as there have been teachers. There has always been that difference.

Mr. **Erdahl.** I do not discount the personal motivation people get from challenges from serving and helping others. That is important.

This reminds me of the story of the little country congregation where the tradition has been in many of our churches—and it is also similar in education—that we ought to have our teachers and preachers being poor and humble.

And one of the deacons prayed: "Lord, we will keep him poor and you keep him humble."

I am not sure we need to pursue that type of thinking. We live in a society that gives very few rewards. I think one of the few rewards that we should not ignore is the adequate compensation for those who dispense knowledge.

I thank you for coming over to this side.

I thank the Chairman.

Chairman **Perkins.** Thank you.

Senator Dodd, we want to thank you.

Excuse me; Mr. Goodling?

Mr. **Goodling.** Thank you, Mr. Chairman.

I think that after 23 years in the business, I think you will find that times have changed considerably in relationship to the number of young people who are coming into the profession who want to be a teacher so badly that they are not swayed by those golden opportunities in the private sector.

I think we will have to work in some kind of a coordinated effort with the private sector to perhaps get some of those very talented people on leave and on lease.

Senator **Dodd.** Do not misunderstand me. Obviously the finances are important.

But when you consider what salary they could be making in the private sector as an engineer or scientist along with cars, memberships, country clubs, or whatever else they offer as part of the package, you are never going to make competative what we pay public school secondary teachers.

You will never achieve that. It is a pipedream to assume that somehow we are going to be able to match that. I think we would be wasting our time to do that.

I would not want to focus too much on that. That is the point that I make.

I agree of course these are people who need to receive fair and decent compensation.

Mr. **Goodling**. A lot of those opportunities were not as prevalent as they are now.

Senator **Dodd**. That is true.

Mr. **Goodling**. Also, the teaching profession, even when I began, was a very respected profession in the community. They did not pay us very much. They loved us and showered us with attention and with unionization and some of these other things, some of this has disappeared. This also faces us.

That is my inclination. But I do think if we can find a more cooperative exchange with the private sector, there are an awful lot of people out there who would enjoy a semester of teaching or a year of teaching as an exchange kind of thing, which I think could be beneficial.

There would also be the practical experience.

Senator **Dodd**. As a major part of this issue we have that idea on the Senate side. I think the suggestion of Congressman Miller and others to include the private sector makes some sense.

What we basically are trying to do here is to take people, teachers, who have been plugged in to teach science or math and who are doing so now without any of the real qualifications to do so, and provide them with some training through workshops and other measures. The object is that the ones who are already in the profession and who are teaching the courses can, in effect, receive necessary training so they can better communicate with their own students in that area.

That is a modest effort at least in the short-term to fill the gap.

Mr. **Goodling**. I have asked staff to look at the studies that have been done post-sputnik. I was in the profession at that time. I am not quite sure what we got in return for the amount of money that we poured into retraining and additional training to do those National Science programs.

I yield to Mr. Miller.

Mr. **Miller**. When you look at the studies, I think you might do this. I do not know how it would be quantified, or if there are any studies, but what I think is clear is this.

That generation was clearly prepared to follow on in the areas of science and mathematics, research and development, and commercial development.

Our question now is: Where is the generation that is going to follow on to this one? Are we in any position to prepare people who will be coming into the market to do advance research and development or product development later in this decade or in the 1990's.

We did see a continuance of that effort today where we made these remarkable accelerations in the field of electronics and scientific research.

I think the question is this: We see resources declining at the Federal level and at the local level. You have the acknowledged absence of the ability in terms of preparedness by science and mathematics teachers. You have to start raising a very serious question about who steps in the shoes of this generation in terms of making the next kind of leap that we see our trading competitors preparing for and have prepared for for the last several years.

Mr. GOODLING. One of the things that I discovered was that I had lost some fine math and science teachers after they got their additional training because apparently that made them attractive enough to the private sector.

I would like to look at any studies, if there have been any, in that area to see what we can do.

Senator DODD. We can prohibit them from leaving. [Laughter.] We could shackle them to their desks. [Laughter.]

Mr. GOODLING. One of the areas that we should emphasize is the elementary program in relationship to math and science. I think you are going to determine whether you have math and science whizes in the future, depending on how well or what kind of experiences they had in those areas at the elementary level.

In the past there has not been that much emphasis on math and science prepardness for elementary teachers. They have to teach all the subjects. Who can teach all subjects really well? I am not sure too many people can.

So you may have to look at what can be done, particularly in the elementary level.

Sometimes as we start out in the math and science programs, for example, after sputnik, we were gearing into the secondary level. I am not so sure that you will not have to whet the appetite of those youngsters long before they get to the secondary level if, in fact, they are going to follow through in math and science.

Senator DODD. I thank you for those comments.

Chairman PERKINS. Senator, we thank you for your presence.

Senator DODD. Are you finished with me, Mr. Chairman?

Chairman PERKINS. Yes, you are excused.

Our next witness is Mr. Willard McGuire, president, NEA.

We welcome you here today; you may proceed.

[Prepared statement of Willard McGuire follows:]

PREPARED STATEMENT OF WILLARD H. MCGUIRE PRESIDENT, NATIONAL EDUCATION ASSOCIATION

Mr. Chairman, I am Willard McGuire, president of the 1.7 million member National Education Association (NEA), which represents teachers, higher education faculty, and education support personnel in all fifty of these United States.

I am extremely pleased to be able to present NEA's views on the American Defense Education Act (ADEA) (H.R. 6674). Just as the National Defense Education Act, passed in 1958 and strongly supported by the NEA, was successful in revitalizing American science and technological education, we feel that the ADEA will provide a vital shot in the arm to local school boards at a time when our needs for science and technical training, and foreign language development, are greater than ever before.

As a representative of nearly three quarters of the nation's public school teachers, and as a classroom teacher of math and Spanish, I appreciate this opportunity to forcefully endorse the ADEA—an essential education measure which responds to a national need for more sophiscated and successful science and technical instruction.

I would like to commend you as legislators for your role in bringing this important act to the attention of the American public by holding these hearings. Your insights into these educational problems provide our nation important leadership on this key question for the future.

It appears that the public is also concurring with your views regarding the importance of education as a federal priority at this time. A September 1982 Phi Delta Kappa publication of the most recent Gallup Poll on public attitudes towards public schools proved this. To quote from the article, "If Congress listened to the American people, public school education would receive far more money from the federal government than it now does." Twenty-one percent of those polled this year ranked public school education as their first priority in the distribution of federal funds and fully fifty-five percent of those responding ranked education as either first, second or third in their consideration of the distribution of federal monies.

President Reagan's Commission on Excellence in Education, a blue-ribbon panel appointed last year to study the effectiveness of the nation's schools and recommend ways to improve performance will be holding a series of hearing around the country in the coming months to focus on education topics and needs. Numerous education and research groups, including the Chief State School Officers, the Education Commission of the States, the Carnegie Commission and the College Board, among others, have also sponsored conferences, institutes or have carried out studies on the future of education vis a vis technological change and economic growth.

This is indeed a fitting time for you as legislators to carry out your mandate of public information and education on the issues confronted and dealt with in the American Defense Education Act.

As I have already suggested, large segments of our society-including its public school teachers—recognize that we as a nation are facing some severe education problems, and that we need to develop effective solutions to these problems. Among these problems, and those that I plan to touch on in our testimony today include: are we indeed on the brink of a crisis in education today, and if so, where do the problems arise, and how can they be tackled: what do future demographic, labor force and economic trends portend for our country, and how will we meet the needs they create: why the ADEA would respond to these above concerns, and why we as a nation can and must afford it; and finally why we as teachers are particularly concerned and involved with the outcome of the ADEA.

IS THERE AN EDUCATIONAL CRISIS

As most of us realize America's greatness in the future lies in her ability to stay as a leader in the development of advanced technology, maintain an edge in the increasingly competitive international marketplace, and have a national defense system that is truly secure—both from outside threats and internal decline. Sustaining economic growth can be a crucial foundation for maintaining our place in the world, and underlying that growth is the critical need for a skilled labor force. The Brookings Institute has cited increasing education as the major source of growth in the U.S. since 1930. They argue that improved education accounted for two-thirds of the increased growth in the American economy from 1948 to 1973, a 25-year period of remarkable economic growth that was coupled with an extraordinary increase in public investment in education. Yet, sadly, a report prepared by the Education Commission of the States, "Information Society: Will Our Graduates Be Ready?" predicts that skilled labor shortages will be the major obstacle to future growth in the U.S. Indeed, we will face a crisis if we do not begin to seriously concentrate on preventing these shortages.

A CLOSER LOOK: MATH AND SCIENCE PROBLEMS

Currently, American youth in the 16,000 school districts across the country are not adequately prepared to take on the economic, technological or national security challenges facing the nation. Scientific and technical learning, as well as communication and foreign language study in the U.S. has not only failed to keep up with advances in these areas in the past two decades, they have actually declined.

Fewer students are taking fewer courses and spending fewer hours studying math and science, foreign languages and communication skills. A 1980 survey prepared by the Center for Education Statistics of a representative sampling of high school senior graduates in the U.S. revealed that only one-third of those sampled had taken three years of math or more. While more than half of students in academic programs had taken at least three years of math, only a fifth of the general and vocational students graduate with three years of math.

The survey revealed a similar outcome with regard to science training in the U.S. Only 41 percent of academic students completed three or more years of science courses, with 13 percent of general students and 9 percent of vocational students taking that same number of years in science.

Feeding into this problem is the fact that the federal government's commitment to research and development and to science education in general began to decline in the late 1960's, with support to graduate fellowships in science and math falling off sharply. In addition, support for teacher training institutes and curriculum development dropped off dramatically in the 1970's, and has virtually disappeared in th ensuing years.

There is a growing shortage of math and science teachers. There are chronic vacancies for math teachers throughout the nation, with some school districts experiencing as much as a 25 percent vacancy rate. This has forced many school districts to hire teachers without adequate training in math.

Moreover, in the sciences, vacancies for teachers run high also. For example, there are only 10,000 physics teachers in the nation's 16,000 school districts. A study prepared by Iowa State University and released last week verified this crisis. A survey of education departments in 45 states in 1979-80 and in 1981-82 revealed that 40 state offices reported either shortages, some critical, of mathematics teachers, and 39 reported shortages, again, some critical, of chemistry teachers. Such findings reveal that U.S. education in the areas of math and science will not provide adequate preparation to respond to defense, technological or economic challenges awaiting us in the future.

SAFEGUARDING OUR LINKS WITH THE WORLD: FOREIGN LANGUAGE NEEDS

Proficiency in and emphasis on foreign language skills are paralleling their sister skills in math and science in the country: to point, they are on the decline. This is happening at a time when our country is experiencing a greater economic and cultural interdependence with other nations than at almost any other time in our history.

During the 1960's, teacher training for foreign languages received federal subsidies, and foreign language enrollment in both secondary and postsecondary institutions was high. As a study prepared in 1979 by the President's Commission on Foreign Language and Area Studie, "Strength Through Wisdom: A Critique of U.S. Capability" showed, in the mid 60's nearly a quarter of all secondary students studies foreign languages; over a third of all colleges in the U.S. had admission standards requiring foreign languages.

These figures for this decade are drastically reduced: 15 percent and eight percent respectively. In addition, only four percent of today's high school graduates have studied a foreign language for more than two years. And, less than one percent of all American students enrolled in foreign language programs are studying Chinese, Japanese, Arabic and Russian, which together comprise 80 percent of the spoken languages of the world.

In his book, The Tongue-Tied American: Confronting the Foreign Language Crisis, Rep. Paul Simon (D-Ill.) stressed the lack of emphasis on foreign languages from the point of view of the federal government's employment needs when he stated, ". . . Only twenty-six federal positions are now designated as requiring Mandarin Chinese. For the most powerful nation on earth virtually to ignore the language spoken by more people on the face of the earth than any other simply defies belief."

To better understand how these educational short-comings are going to affect us, I'd like to take a moment to review some factors that will be key in determining the future direction of our society. These include demographics, technologic changes, and international economic demands.

CHANGING DEMOGRAPHICS

Our country is currently in the midst of some of the most striking demographic shifts in its entire history. They will most definitely affect all aspects of our society. Let's look at some of the specifics:

The Census Bureau predicts that our population will increase by 18 percent by the year 2000—jumping from the 1980 figure of 226.5 million to 267 million.

The median age of Americans will climb from 29 in 1977 to 33 by 1990. By 2000, there will be more than 36 million Americans over the age of 65, and they will constitute more than 13 percent of the population.

A "baby boomlet" is expected to occur through 1985, as the number of women between the ages of 18 and 34 moves from 32.1 million in 1979 to 33.9 million in 1985.

Minorities will account for more than half the population increase in the next two decades because of high birth rates and immigration. By 1985, the non-white population will equal more than 22 percent of the total U.S. population, while white, non-Hispanic Americans will drop from 80 to 75 percent of the population.

There will be a steady shift in population from the Frostbelt to the South and West, and in the Southwest, population growth will occur most among Hispanics.

These demographic changes will be pivotal in determining several other factors related to labor force participation and education. For example, the number of women entering the workforce has been growing phenomenally, and this trend is expected to continue. Over half of all women between the ages of 18 and 64 now work, and by the end of the decade, nearly 70 percent of this same group will be in the workforce. This trend, and the increase in single-parent households will create a heightened demand for day-care and flex-time arrangements.

In addition, the growth of the Hispanic, as well as other non-English speaking populations in the U.S. has dramatically increased the need for bilingual education programs within our own boundaries. It is projected, for example, that nearly 30-40 percent of the labor force growth over the next decade will be primarily Hispanic in origin. With such a large share of our labor force growth dependent upon the Hispanic population, it will be imperative to raise the proportion of high school graduates among Hispanics above the current 55 percent level. Also, the recent Supreme Court ruling that children of illegal immigrants have the right to a public school education will also clearly accelerate the demands Hispanics will place on the educational system.

Perhaps the most critical crisis, however, to be faced by our society will be the new demands created by a technological explosion in an increasingly competitive international environment. The challenges of these factors will be explored in the next two sections.

THE TECHNOLOGICAL REVOLUTION

The revolution in technology is changing our society at its very roots. It is catapaulting the workplace into a laboratory of innovation and change; replacing our former goods-producing economy into one based increasingly on service and information; basically restructuring our means of communications, and, in general, speeding up the pace of life. Specifically:

The computer and its component industries are showing remarkable growth; this, in turn, will impact greatly on existing industries and skill requirements.

Many routine jobs now performed by low skilled workers will be done by robots ten years from now. Jobs in these "robotized" industries will require special technical skills, as well as more knowledge and autonomy by personnel in evaluating and responding to complicated technical information.

The onslaught of the "information revolution" will create a need for workers with competency in computer literacy, statistics, perhaps a foreign language, and skills in engineering and the hard sciences.

There will be a continued and growing demand for scientists, engineers and technicians both within business and industry, and within the military.

THE INTERNATIONAL ECONOMY: OUR NEIGHBORS—OUR COMPETITORS

The heightened competition of the U.S. economy with those in other countries has increase dramatically in the past two decades. Countries such as Japan and West Germany, whose economies and industries were literally wiped out less than four decades ago, have been important trading partners with the U.S., and increasingly our toughest economic rivals. This trend promises to continue as our economy becomes oriented more toward the service and information sectors, and less in manufacturing.

For us to maintain a prominent place within the world marketplace, we must begin to strategically plan our educational goals. A review of education policies and programs in other countries may shed some light on the direction we should be taking, because the path currently followed by the U.S., and that being pursued by most other industrialized and Third World countries differs greatly. For example, two of America's top competitors, one political—the Soviet Union—and one economic—Japan—have intensive education and technical development programs for their youth.

An article appearing in the October 14, 1981 Congressional Record, "Investing in People" by Howard Samuels, revealed that 98 percent of all Soviet children now complete mandatory 10 year primary and secondary school programs, while only three-fourths of all American students finish high school. In addition, nearly every Soviet student received 10 years of math, five years of physics, four years of chemistry, five and a half years of biology, five years of geography, as well as years of training in other technical subject areas.

Japan, with a population less than half as large as that in the U.S., is graduating as many engineers every years as is this country.

In addition to these statistics, material prepared for a recent Convocation on the State of Pre-College Education in Mathematics and Science by the National Academy of Sciences and National Academy of Engineering highlights programs showing that most Communist bloc and Third World countries are strengthening their pre-college math and science programs with:

National education policies emphasizing the importance of science and mathematics to economic and cultural progress. In the People's Republic of China, for example, science education policies are written into the constitution.

Specialized study in the sciences beginning in the sixth grade, with requirements in math, biology, chemistry, physics, and geography. Students spend roughly three times the number of class hours on these subjects than do their American counterparts who elect to study these subjects.

Secondary school programs balancing science and math courses with about an equal number of social science, language and humanities courses. This means that students are required to carry seven to nine courses per semester.

English is regarded as the "language of science", and is therefore widely promoted for study. Currently in the People's Republic of China, there are more students and adults learning English than there are English speaking people in the U.S.

Science and math teachers are trained in specially designed programs in universities, teaching institutes, normal schools, or teachers colleges. The countries have provisions for a continuing program of in-service education, with local colleges and universities responsible for such training.

These countries have programs for developing mass scientific and technological literacy. The People's Republic of China has the most diversified program, with its national symbol the Bohr atom model with the slogan, "Science is the Eternal Spring."

Many of the programs cited above have counterparts in most industrialized countries of the world, such as Japan and West Germany, to name only a few.

MILITARY AND DEFENSE NEEDS

Shifting the focus slightly from the international economic arena brings us to the sometimes difficult, but ever present area of defense. As the revolution in technology has impacted on nearly every facet of our lives, so has it also—perhaps even more dramatically—in terms of our defense structure. Weapons and weapons systems are increasingly complex and sophisticated, and they require increasingly well trained and highly skilled people to operate them.

To put this into perspective, it may be helpful to look at how "skills" needs have changed within the Armed Forces. In 1945, the Navy required that only 23 percent of its personnel be highly skilled, but by 1980, the role of semi-skilled personnel was sharply reduced, while the percentage of highly skilled personnel jumped to 42 percent. Currently, 70 percent of all Army jobs require some technical training, while 75 percent of Navy jobs require skilled or highly skilled personnel.

Despite this greatly increased need for skilled personnel, the pool that the Armed Forces currently has to choose from falls short of those needs. In recent years, the military has been forced to rewrite its training manuals from the 11th-grade level or higher to the 8th-grade level or lower. Many are aimed at the 6th-grade level.

What this shows clearly, we believe, is that programs such as Chapter I of the Education Consolidation and Improvement Act (formerly Title I), established to aid students in sharpening their reading and math skills still need to be emphasized. Title I has begun to make inroads into higher achievement for many in the nation's 16,000 school districts, but even at peak funding, the program reached only 45 percent of the nearly 11 million children classified as "low achievers". The Reagan Administration has repeatedly proposed slashing funds for this vital program in its fiscal year 1983 budget.

But the increasing sophistication of military technology and management needs in the armed services calls for a great deal more than boosting basic skills. Great strides must be made at both the basic and advanced levels in math, science, technology, and communications skills if the nation is to be able to answer to the need for technical training in the maintenance and operation of weapons systems and personnel.

WHY THE ADEA—WHY NOW

Education programs aimed at stengthening national priorities such as defense, technological developments, and economic performance of the country as a whole must have support at the federal level of government. In 1958, the U.S. Congress passed the National Defense Education Act as a response to the launching of Sputnik. This program did more to promote science, math, and foreign language education in the U.S. than anything preceding it for following it. There is no Sputnik II today. Yet, the factors calling for a reaffirmation of federal support for education are stronger now than when Sputnik was launched.

The federal role in education has centered largely around questions of equity of access and excellence of education in the past two decades. There has been a major effort to assure that every young person—whether from a poor school district, whether handicapped, or from a disadvantaged background, or unable to speak English as a first language—would have an opportunity to be educated to the best of his or her ability. There is much work which still remains to be done to achieve that goal.

The Reagan Administration has chosen to turn back the clock on those programs designed to give every youngster a chance. Gutting program budgets has a clear end—no programs. Without a real opportunity for an education for disadvantaged students, the "American Dream" becomes a reality only for the elite few rather than for all. But pushing elitism in education seems a clear goal of this Administration in its promotion of tuition tax credits. This legislation directly, and we believe unconstitutionally, subsidizes private schools and the parents of private school students at the same time that the Administration has been asking public school students and their families to tighten their belts and to expect far less for education from the federal government.

Our efforts to achieve equity of access and opportunity must continue unrelentingly. But, we must also move on the second goal of the federal role in education. We must be sure that our investment in the future is secure by moving to meet the challenges of the future.

As teachers—the citizens responsible for educating our nation's children—we are concerned with the direction of our education program, and the federal commitment to them in the coming decades. We are the ones who must face the reality of the effects of the current financial crisis on the schools. As much as we are now focussing on the need for improving math and science skills and equipping the schools with computers and other materials that will carry us into the next century, the bottom line is that our schools are having to make much more basic choices. They are having to choose between new books, pencils and paper and teachers. They are being forced to decide whether to keep art and music or to slice remedial reading and math programs, not whether to add dynamic new classes on data processing or a third year of French. The money is just not there in the majority of the local school districts.

And for many, turning to the states for help is no longer the solution. States, too, are in a financial squeeze, with a number of them running big deficits. This situation promises only to be aggravated in the future as federal funds diminish, and states are forced increasingly to make choices between building and repairing bridges and roads, and funding their schools, among other difficult dilemmas they will face. The need for a renewed federal financial commitment is clear.

Moreover, the problems confronting the schools right now are obviously broader than just financial. One of the strengths of our nation's education policy is that it is administered and operated at the local level. With 16,000 school districts in the country, each with its own governance, there is strong local control but in meeting national needs it is clearly a non-system of education. In some instances where quality of education and equality of access has been missing—or lagging—school boards and administrators have not paid adequate attention to problems. In others, the problem has been few or no resources, even if intentions have been the best. The kinds of problems and issues we are dealing with now—the dire need to prepare our students for an increasingly complex and sophisticated labor force and society—are national in scope and they require a national partnership with local schools to deal with them effectively. Our students—whether from the east or west, from a wealthy or poor school district—must have access to the education and skills training that will equip us as a nation to compete in the future.

We realize that currently there are many proposals being offered as a solution to some of these major problems. Among these is a band-aid suggestion that pay differentials to teachers of math and science may be the way to induce students in these areas to enter teaching. We are opposed to any such method of recruitment because of its basic short-sightedness. It is discriminatory toward other teachers, and it works to the detriment of education in other subject areas. Recruiting well-prepared teachers of English or languages is equally important as hiring good math and science teachers. The pursuit of all-around quality should stay as a guiding education policy. We need to avoid the temptation to overcompensate in one area, letting others go, until twenty years or so down the road when we have to develop new programs to deal with deficiencies created by the very programs aimed at eliminating deficiencies.

ADEA: A TRULY JOINT VENTURE

We at the NEA feel that the ADEA, H.R. 6674, represents the best possible course for our nation to follow to reinforce and strengthen our education system. It represents a national recognition of a national problem, proposes a national financial commitment to help overcome this problem, yet requires the solutions to come through a local commitment to local programs. At a time when many are questioning the efficacy of the "Washington-based", federal program, ADEA offers a refreshing and promising alternative.

ADEA gives local school districts the incentives and resources to improve the programs that impact on the national priorities outlined in this statement. In fact, it is this locally-based, locally-operated aspect of the ADEA which gives it its predominant strength. Local school districts, in conjunction with community and business leaders, school boards, teachers and others interested in education, will be encouraged to work togther to develop the appropriate program for their local area. This might entail improved curriculum design, preparation for specific courses, or providing for special teacher training in certain subject areas. The possibilities of a community-wide process for finding local solutions to a national crisis are endless in terms of tighter standards, better prepared teachers, and modern equipment. Local schools, for example, could use the incentive payments, as they did under the National Defense Education Act, to purchase or lease computers, data processors, telecommunications, or other vital technological equipment.

ADEA funds used in this way could also prevent what members of the Commission on Excellence in Education fear may develop regarding the creation of a "new generation of 'haves and have-nots'" based on students' access to microcomputers. This "haves and have-nots" dichotomy could particularly affect black and minority students who predominate in urban school districts where fewer funds are available for purchasing computers. Without access to computers and teachers prepared to use them students in hard-pressed areas could be labelled "educationally disadvantaged", to again quote the Commission's findings. Thus, ADEA could serve as an important catalyst in helping all students gain a needed advantage as they go to compete in the nation's labor force in later years.

ADEA funds could also be used to have schools work together with already established local industries—or with those in search of homes—so that needed industrial and technical skills can be developed in that particular community. This advantage could keep industries from moving to other localities, or other countries, and would directly spur economic growth in the U.S.

ADEA: HOW IT WOULD WORK

H.R. 6674 establishes participation requirements for the local school districts which choose voluntary participation in the ADEA program. These include an assessment of both instruction and achievement in mathematics, science, communication skills, foreign languages and tehnology; and preparation of overall goals to prepare students in such schools for employment, technical training, higher education, and citizenship, including service in the nation's defense.

THE AMERICAN DEFENSE EDUCATION ACT: WHAT IT WOULD DO

The ADEA authorizes a national program to improve the quality of instruction in the fields of mathematics, the sciences, the communication skills, foreign languages, technology and guidance and counseling, in addition to reaffirming equality of access to education for all. Though federally-funded, the program is to be developed and implemented by local school districts who wish to participate.

The ADEA reaffirms many of the concepts on which the federal role in education has been built since the early years of the nation.

It specifically reaffirms:

The fact that a well-educated citizenry is necessary to preserve a free and democratic society, to continue a productive economy, and to maintain national defense.

The long-standing federal policy of requiring the states to establish systems of public education, and encouraging the states and localities to maintain and improve their public schools.

Congressional recognition, through passage of the Education Amendments of 1974, that the nation's economic, political and social security require well-educated citizens, reaffirming the goal of equal education opportunity, as well as the national policy that every citizen is entitled to an education to meet his or her full potential without financial barriers.

Congressional implementation of the policy of equal opportunity in education through passage of various laws, for which the cost of compliance has been borne to a great extent by local school districts, with some assistance from the States, and to a much lesser extent, from the Federal government.

Severe financial stress on local school districts, as well as changing circumstances, which has diminished the quality of instruction in mathematics, the sciences, foreign languages, communication skills, new technology, and adequate guidance and counseling;

The need for federal assistance to local school districts for programs which are vital to the national defense, keeping in mind that the states and localities have, and should retain, control over the primary responsibility for, public education;

The need for incentives to be provided for local schools to improve the quality of education especially in mathematics, sciences, foreign languages, communication skills, new technology and other programs as they relate to the national defense.

The bill establishes participation requirements for the local school districts which participate in the ADEA program. These include an assessment of both instruction and student achievement; the development of specific plans for improving instruction and achievement in mathematics, science, communication skills, foreign languages and technology; and preparation of overall goals to prepare students in such schools for employment, technical training, higher education, and citizenship, including service in the nation's defense.

To measure the progress of programs developed with ADEA assistance, local school districts are to establish yearly evaluation systems, which will be developed with participation from the school board, administrators, teachers parents, appropriate bargaining agents, business and industry, and the community. This written evaluation will be on public record.

During each fiscal year, school districts working with the ADEA program will be entitled to a basic payment of two percent of the average per-pupil expenditure in the state, (but not less than the average per-pupil expenditure in the United States), and those which can show substantial evidence that the program meets the ADEA goals for the year will receive an additional two percent payment as established above.

Administration of the ADEA program will be under the auspices of the Department of Education. In addition, the Secretary of Defense will be required to project the personnel training needs of the Armed Forces for the following four years, and in conjunction with the Secretary of Education and local school districts, prepare an analysis of the educational needs of the Department of Defense to assist in efficient personnel development.

As you can see, at the same time that the ADEA provides local school districts and communities with great autonomy and independence in designing and implementing programs, the built-in safeguards described above help ensure that the original intent of the legislation is actually carried out.

CAN WE AFFORD EDUCATION EQUAL TO THE FUTURE CHALLENGES

There are various ways to consider whether we as a nation can afford the education necessary for our future defense, productivity and international competition—our technological future. One is tempted to question how we can afford not to educate our citizens, but there are in fact more compelling arguments to say that we can and must afford such expenditures.

The fact that we are in perilous economic times with ballooning deficits is a fact of our daily life. At other times when the nation was in crisis we chose to invest in the future while dealing with the present—rather than mortgaging the future to deal with a current problem. During the Civil War, America launched the program for land grant colleges—a national education initiative. During the First World War, America launched the vocational education program—a national education initiative. During the Second World War America launched the GI Bill—a national education initiative. At those times it took Congressional wisdom and strength to plan for the future and it will take that same leadership today.

This Administration which has no education program except for platitudes, prayers, and private schools finds sufficient resources for a tuition tax credit proposal. The ADEA would cost no more on a per pupil basis than the Reagan proposal—although it would clearly cost more in the aggregate since it would be a program to improve the education of ninety per cent of children in school rather than ten per cent.

This Committee must answer the question of whether resources are available at other levels of government to carry the burden for meeting this national need. Due to property tax pressures and lack of sufficient local tax bases, the state's role in financing education is growing more important. According to NEA Research figures, published in Ranking of the States, 1982, states now provide 49 percent of public school revenues, the federal government 8 percent, and the local jurisdictions 43 percent. State surpluses have fallen from $11 billion in 1980 to $4.7 billion in 1981 and those surpluses are concentrated in 12 energy-rich states. During 1982 spending is expected to exceed revenue at the state level by $5 billion. In a partnership of education at the local, state, and national level it is clearly time for the federal government to contribute its share.

As a country we are deeply concerned about a defense strong enough to protect us in the future. But the defense budget proposed by this administration is only a hardware defense—the human element of who will work the sophisticated equipment, who will lead and train the soldiers, who will fight if that need be, is untouched in the budget. The $1.6 trillion dollar build-up proposed from fiscal year 1981-1987 strips our nation of the resources to prepare our citizens for the future. Less than one-quarter of one percent of that build-up would fund the American Defense Education Act.

CONCLUSION

Mr. Chairman and Members of this distinguished Committee, the National Education Association comes before you to ask that you again take the leadership in the Congress to call the attention of the American people to a national problem: that the challenges of the future for our country—for our defense, for our role in international competition, for our productivity, for our technological future—demand that there be excellence in education. Excellence in education is not only a slogan. It must be the resources and the incentives for local school districts to work with the whole community—teachers, labor, business—to improve the quality of instruction in the fields of mathematics, sciences, communication skills, foreign languages, new technologies, and guidance and counseling. Meeting the challenges of the future requires a partnership between the federal level and the 16,000 local school districts across America to meet a national challenge. We believe that it is best met through continued support of basic programs protecting access to educational opportunity and enactment of the American Defense Education Act. We stand ready to work with you toward these goals.

STATEMENT OF WILLARD H. McGUIRE, PRESIDENT, NATIONAL EDUCATION ASSOCIATION

Mr. McGuire. Thank you, Mr. Chairman.

I have some remarks I would like to make. I would like my entire testimony, which is much longer, to be entered into the record at this time.

Chairman Perkins. Without objection, so ordered.

Mr. McGuire. I am Willard McGuire, president of the 1.7-million-member National Education Association, which represents teachers, higher education faculty, and education support personnel in all of these United States.

I am extremely pleased to be able to present NEA's views of the American Defense Education Act, H.R. 6674. As a representative of nearly three-quarters of the Nation's public school teachers, and as a classroom teacher of math and Spanish, I appreciate this opportunity to forcefully endorse the ADEA, an essential education major which responds to a national need for more sophisticated and successful science and technical instruction.

Most of us recognize that America's greatness in the future lies in her ability to stay as a leader in the development of advanced technology, maintain an edge in the increasingly competitive international marketplace, and have a national defense system that truly is secure.

Sustaining economic growth can be a crucial foundation for maintaining our place in the world. And underlying that growth is a critical need for a skilled labor force.

The Brookings Institute has cited increasing education as the major source of growth in the United States since 1930.

They argue that improved education accounted for two-thirds of the increased growth in the American economy between 1948 and 1973, a 25-year period of remarkable economic growth that was coupled with an extraordinary increase in the public investment in education.

But today we stand at the crossroads. That public investment in education is being questioned at a time when studies have documented that scientific and technical learning, as well as communication and foreign language study in the United States has failed to keep pace with the phenomenal advances in the past two decades.

In fact, learning in this area actually has declined and increasingly American youth in the 16,000 school districts across the country are not adequately prepared to take on the economic, technological, and national security challenges facing the Nation.

Statistics show that fewer students are taking fewer courses and spending fewer hours studying math, science, foreign language, and communication.

In addition, there is a growing shortage of math and science teachers with chronic vacancies occurring in some areas.

Some school districts report as much as a 25-percent vacancy rate of math teachers and there are only 10,000 physics teachers in the Nation's 16,000 school districts.

Without adequate teaching staff, American students cannot be expected to excell in these areas. These teacher shortages and inadequate student preparation may prove harmful as our society faces the new demands created by a technological explosion in an increasingly competitive environment.

The revolution and technology is changing our society at its very roots. It is catapulting our workplace into a laboratory of innovation and change, replacing our former goods-producing economy into one based increasingly on service and information; basically restructuring our means of communications; and, in general, speeding up the pace of life.

The onslaught of the information revolution will create a need for workers with competency in computer literacy, statistics, foreign language, and skills and engineering in the physical sciences.

Additionally, there will be a continued growing demand for scientists, engineers, and technicians, both within business and industry and within the military.

As the revolution and technology is impacted on nearly every facet of our lives, so it also—and perhaps even more dramatically—has on our defense structure.

Weapons and weapon systems are increasingly complex and sophisticated and they require increasingly well-trained and highly skilled people to operate them.

Education programs aimed at strengthening national priorities such as defense, technological developments, and economic performances as a whole, must have the support at the Federal level of government.

As teachers, the citizens responsible for educating our Nation's children, we are concerned with the direction of our education programs and the Federal commitment to them in the coming decade.

We are the ones who must face the reality of the effects of the current financial crisis on our schools. As much as we are now focusing on the need for improving math and science skills, and keeping our schools in step with changing technology, the bottom line is that our schools are currently having to make much more basic choices.

They are having to choose between new books, pencils, paper, and teachers. They are being forced to decide whether to keep art and music or to slice remedial reading and math programs, and not whether to add new dynamic classes on data processing or a third year of French.

The money just is not there in the majority of the local school districts.

We at NEA feel that the ADEA, H.R. 6674, represents the best possible course for our Nation to follow, to reinforce and strengthen our education system.

It represents a national recognition of a national problem and proposes a national financial commitment to help overcome this problem.

Yet it requires the solutions to come through a local commitment to local programs. And at a time when many are questioning the efficacy of Washington-based Federal programs, ADEA offers a refreshing and promising alternative.

The ADEA authorizes a national program to improve the quality of instruction in the fields of mathematics, the sciences, the communication skills, foreign language, technology, and guidance and counseling, in addition to reaffirming the quality of access to education for all.

Though federally funded, the program is to be developed and funded through local school districts who wish to participate.

Many are concerned about cost factors of the ADEA. Viewing it in the light of another Federal priority, defense spending, helps put the ADEA costs in prospective.

The Reagan administration has proposed a $1.6 trillion buildup in defense expenditures between fiscal years 1981 and 1987.

Less than one-quarter of 1 percent of that buildup would fund the ADEA. We must also realize as we determine whether we can afford the ADEA, that we are considering whether we, as a nation, can afford the education necessary for our future defense, productivity, and international competition.

In other words, this is our technological future.

Indeed, these are peerless economic times. This is a fact that we all recognize. And at other times when the Nation was in a crisis, we chose to invest in the future while dealing with the present, rather than mortgaging the future to deal with the current problem.

During the Civil War, America launched a program for land grant colleges, a Federal education initiative.

During the First World War, America launched the vocational education program, a Federal education initative. During the Second World War, America launched the GI bill, a Federal education initiative.

At those times it took congressional wisdom and strength to plan for the future and it will take the same leadership today the same wisdom and strength.

Mr. Chairman and members of this distinguished subcommittee, the National Education Association comes before you to ask that you again take the leadership in Congress to call to the attention of the American people the national problem that the challenges of the future for our country for our defense, for our role in the international competition, for our productivity, and for our technological future, demands that there be excellence in education.

Excellence in education is not only a slogan. It must be the resources and the incentives for local school districts to work with the whole community—teachers, labor, and business, in a partnership to improve the quality of instruction in the fields of mathematics, science, communication skills, foreign language, new technologies, guidance, and counseling, meeting the challenge of the future.

This requires a partnership between the Federal level and the 16,000 local school districts across America to meet a national challenge.

We believe it is best met through continued support of basic programs protecting the access to educational opportunity and the enactment of the American Defense Education Act.

We stand ready to work with you toward these goals.

Thank you very much.

Chairman **Perkins**. Thank you very much.

We will now call Dr. Cecily Cannan Selby.

We welcome you here today.

You may proceed.

[Material submitted by Cecily Selby follows:]

BACKGROUND OF CECILY CANNAN SELBY

The professional career in science, education, management and communications summarized below reflects a dedication to the development of ideas and the strengthening of leadership in institutional settings. Through the policymaking and management responsibilities listed, and through writing and speaking, a commitment has also been made to science, to youth, women and minorities and to fostering links between the layman and the specialist.

Business corporate boards: RCA Corp. (Chairman of Contributions and Public Policy Committee, past Chairman Incentive Compensation), National Broadcasting Company, Avon Products, Loehmann's.

Eleemosynary Boards: Radcliffe College (Chairman Program Planning Committee), Humanities and Nuclear Engineering Visiting Committees at Massachusetts Institute of Technology, Brooklyn Law School, Committee for the Corporate Support of Private Universities, Woods Hole Oceanographic Insitution, The Rockfeller University Council.

Dean for Academic Affairs; North Carolina School of Science and Mathematics, 1980–81. Chairman, Board of Advisors, 1981–present.

Co-Chairman: Commission on Precollege Education in Mathematics, Science and Technology of the National Science Board, 1982–present.

Consultant (Recent): Committee on Science Education, North Carolina Board of Science and Technology, 1980–present.

Aspen Institute Energy Policy Workshop August 1977, National Juvenile Justice Collaboration 1977. MIT Center for Policy Alternatives Workshop "Alternative Strategies for Conservation" for ERDA 1976, Edison Electric Speakers Bureau.

One of 5 Americans, selected for Aspen Berlin Seminar: "Financial Support of Culture and the Arts '75".

Designing a "Public Awareness" Program on the nature, causes and criteria for solutions of U.S. energy problems, Office of Energy programs, Department of Commerce 1976-77.

Author: Science Education: Some Strategies For Success, The Chemist, January 1982.

Science the Fourth R, Science Digest 1980.

Uses of Knowledge: Independent School Bulletin 1979.

Improving the Performance of Non-Profit Organizations, Harvard Business Review, September/October 1978. Reprinted Chemtech 1980.

Publication of speeches on energy in trade journals 1977.

Regularly published articles in Girl Scout newsletters and magazines 1972-75.

Trust and Tradition: Evolution and Entropy, Independent School Bulletin 1970. Edit Press Award.

Winds of Change in Education. American Camping Association Journal 1972.

Chapter in Analytical Cytology, McGraw Hill Book Company 1957.

Thirteen original research articles, in referred scientific journals 1950-58.

President: Americans for Energy Independence, Washington, D.C., non-profit educational organization founded to promote, through public opinion, the conservation of energy and the maximizing of domestic resources. Organized 18 local chapters, spoke to public and trade organizations, presented testimony to governmental committees, developed programs on conservation, jobs and energy, etc., February to September 1976.

National Executive Director: Girl Scouts of U.S.A. Responsible for all operations, $30 M budget and the direction of 12 departments (financial planning, public relations, funds raising, personnel, programs and training, legislative activity, MIS, magazines, merchandising, etc.) 700 staff members (6 field offices). Provided services for National President and Board, and for 360 local councils with a staff of 3,000. Inititated and maintained relationships with the federal government, national voluntary service organizations, major corporations and foundations. January 1972-September 1975.

Headmistress: Lenox School (Independent; Girls, Grade 1-12) N.Y. 1959-72.

Instructor: Cornell Medical College 1955-57 (Cell ultrastructure).

Assistant member: Sloan-Kettering Institute for Cancer Research September 1950 to August 1955 (Electron Microscopy, cancer, research).

Past board member: Massachusetts Institute of Technology 1974-79, Women's Forum 1977-79; Simmons College Management Program 1976-78; National Association Independent Schools, New York State Association Independent Schools; New York Guild of Independent Schools; National Association Principals Schools for Girls; Headmistress of the East (President 1970-72); Grace Church School (N.Y.C.); Kirkland College Advisory Board; Chairman Radcliffe Class of 1946, 1971-76; Chairman Radcliffe Development Fund N.Y. 1958; Creative Arts Rehabilitation Center (N.Y.).

Education: Ph.D. Massachusetts Institute of Technology, 1950 Physical Biology. A.B. Cum Laude, Radcliffe College, 1946 Physics, Aspen Institute, Executive Seiminars in Humanities, 1973.

Personal: Born London, England, February 4, 1927, U.S. Citizen, Husband: James S. Coles, President Emeritus, Bowdoin College, President Research Corporation, a foundation for the advancement of science. Corporate Board Member. 3 adult sons (Norman, William and Russell Selby) Memberships: Women's Forum; Cosmopolitan Club Honorary Societies: Sigma Xi, Cum Laude Regent Extensive foreign travel.

[From the National Science Foundation News, Apr. 28, 1982]

EDUCATION COMMISSION TO EXPLORE IMPROVEMENT IN SCIENCE, MATH ACHIEVEMENT

Solutions to this country's critical need for high school graduates with solid backgrounds in science and mathematics will be explored by a new Commission on Precollege Education in Mathematics, Science and Technology just established by the National Science Board (NSB). The NSB is the policymaking body of the National Science Foundation.

The Commission of 20 highly respected individuals from a wide variety of fields was appointed by the NSB and will be co-chaired by William T. Coleman, Jr., former Secretary of Transportation and now a senior partner in the law firm of O'Melveny and Myers, and by Dr. Cecily Cannan Selby, formerly National Executive Director of the Girl Scouts, U.S.A., and chairperson of the Board of Advisors of the North Carolina School of Science and Mathematics.

The purpose of the Commission is to define a national agenda for improving mathematics and science education in this country. It will develop an action plan that will include a definition of the appropriate roles of federal, state and local government, professional and scientific societies, and the private sector in addressing this problem of national dimension. Expected outcomes are the identification of the steps to be taken, the assignment of responsibility for action, and a time table for their accomplishment.

"The quality and accessibility of education for our young people puts a limit on everything we can accomplish as a Nation," said Dr. Lewis M. Branscomb, Chairman of the NSB and Vice President and Chief Scientist of IBM, Inc. "Already many citizens on their own initiative are working to improve their schools; many mathematicians, scientists and engineers, worried about the quality of secondary education in their disciplines, are looking for ways to strengthen it. The Commission will seek to encourage professional societies and other organizations already at work on this problem. We expect the work of the Commission to lead to clear action plans for improving the quality of secondary school science and mathematics."

Dr. John B. Slaughter, Director of the National Science Foundation, said, "The decline in student achievement in mathematics and physical sciences at the precollege level has reached a point where this country's strength in science and technology may be affected.

"Education is a function assigned to state and local governments, but the quality of that education as it affects American industrial productivity, employment opportunity and social progress is a national concern. We must find ways to reverse the decline in precollege education in science and mathematics. Establishing the Commission now is an important step toward this goal. I view it as the most important matter I will face during my tenure as Director of NSF."

Mr. Coleman said, "I view the purposes of the Commission as highly important to the economic and social development and to the future security of this country. We need to focus our attention and that of the public on the sagging quality of science and mathematics education, what that means, and then determine what might be done to reverse that trend."

"The potential for successful and rewarding work in science and mathematics can be found in countless able and eager students in every community across the Nation," Dr. Selby said. "The resources for the critically-needed improvement in their education exist in our educational, scientific, technological, industrial, and military communities. Top priority must be given to reallocation of these resources to better serve their needs and aspirations and those of our scientific and technological communities.

The Commission will be active over a period of 18 months and is expected to issue interim reports on its findings at six-month intervals. In the course of its meetings it will:

Examine existing evidence on the quality of general and pre-professional secondary school education in mathematics and science.

Develop an understanding of the roles that government and private organizations, professional groups and individuals can play in improving mathematics and science eduction.

Identify where current policies fail to ensure the entry, selection, education and exploitation of the full range of potential talent in science, mathematics and engineering.

Specify existing mathematics and science programs, teaching materials and teaching techniques whose success justifies imitation.

Establish a set of principles, options and strategies which can be used to improve the quality of secondary school science and mathematics education.

Commenting on the Commission, Dr. George A Keyworth, Director, Office of Science and Technology Policy and Science Adviser to the President said, "The Commission will be addressing a problem of national magnitude. I believe the Commission will be capable of developing visionary initiatives. It will identify ways for all of the concerned communities to work together in addressing the problems of math and science education in our secondary schools."

BACKGROUND INFORMATION—NSB COMMISSION ON PRECOLLEGE EDUCATION IN MATHEMATICS, SCIENCE AND TECHNOLOGY

THE NEED FOR A COMMISSION

The National Science Board and the Director of the National Science Foundation have established the Commission because they believe that the quality of mathematics and science education has declined to a near-crisis level in a majority of the Nation's public schools. The Commission has been directed to develop a national action plan to address this situation. Evidence of the need for the Commission includes:

PRECOLLEGE STUDENTS

Between 1960 and 1977, the proportion of public high school students (grades 9 to 12) enrolled in science and mathematics courses declined—from 60 to 48 percent in the case of science.

Since 1970 there have been a nationwide trend toward reduction of high school graduation requirements. Only one-third of the nation's 17,000 school districts require more than one year of mathematics and science for graduation. At the same time colleges and universities have reduced the amount of mathematics and science required for admission.

There has been a steady decline in the science achievement scores of U.S. 17-year-olds as measured in three national assessments of science (1969, 1973, and 1977).

Mathematics scores of 17-year-olds declined significantly in two national assessments of mathematics (1973, 1978). The decline was especially severe in the areas of problem solving and the applications of mathematics.

The mathematical and verbal Scholastic Aptitude Test (SAT) scores of students (approximately one million college-bound students, largely from the top two-fifths of U.S. high school graduates) have declined steadily over an 18-year period through 1980.

PRECOLLEGE SCIENCE AND MATHEMATICS TEACHING

There is a severe and growing shortage of mathematics and physical science teachers in the nation's secondary schools.

In 1981, 43 states (of 45 responding) reported a shortage or a critical shortage of mathematics teachers. For physics teachers, 42 states reported shortages or critical shortages.

In 1981, 50 percent of teachers newly employed nationwide to teach secondary science and mathematics were actually uncertified to teach those subjects.

Experienced science and mathematics teachers left classroom teaching for nonteaching jobs at a rate of 4 percent per year in the years 1980 and 1981. In addition, 25 percent of those currently teaching have stated that they expect to leave teaching in the near future.

From 1971 to 1980, student teachers in science and mathematics decreased in number—threefold in science and fourfold in mathematics—and only half of these have been entering the teaching profession.

COLLEGE SCIENCE AND MATHEMATICS TEACHING

Remedial mathematics enrollments at 4-year institutions increased 72 percent between 1975 and 1980—compared to a 7 percent increase in total student enrollments for the same period. In public 4-year colleges, 25 percent of the mathematics courses are remedial. At 2-year colleges 42 percent of these courses are remedial.

A recent National Academy of Sciences study documents a decline in the science courses taken by college students not specializing in science, engineering or other science related professions. In 1980 the average nonspecialist devoted only 7 percent of course work to science.

U.S. PUBLIC

A national study conducted in 1980, shows that 18 percent of the U.S. adult population is interested in and informed about scientific matters. The proportion varies from 4 percent for persons with less than a high school degree to 55 percent for those with a graduate degree.

Only a small percentage of Americans indicate they would definitely take an active part in controversies involving science and technology and only one in seven have a minimal understanding of what it means to study something scientifically.

Industry, business, and the military commonly report that new employees and recruits lack the competence for a broad range of increasingly technical jobs.

INTERNATIONAL COMPARISONS

One-half of all high school graduates in the U.S. take no mathematics or science beyond the 10th grade.

In contrast, in Japanese secondary schools, nearly all of the college-bound students take three natural science courses and four mathematics courses during their 3-year high school career. Japanese 13-year olds have the highest math achievement scores among 12 countries including the United States and several European countries.

In West Germany, the general preparation is similar. There is a standard curriculum for all students through the 10th grade, and the only variation is in specialized science-oriented schools where each subject is studies more intensively.

The Soviet Union has instituted a general curriculum reform at the primary and secondary levels which, in terms of its heavy focus on science and technology, is the most advanced in the world. The number of high school students taking calculus each year in the Soviet Union has reached 5 million. For the U.S. the comparable number in 1977 was 105,000. In addition to two years of calculus, all youngsters in the Soviet Union are required to complete 5 years of physics, 4 years of chemistry, 4 years of biology, and 5 years of algebra, amoung other requirements.

A recent report by the Committee of Inquiry into the Engineering Profession in Great Britain (the "Finniston Report") laid Britain's declining ability to compete in international trade squarely on the lack of vigor of its engineering profession.

On a per capita basis (for the relevant age group) for each engineering graduate produced per year in the United States, the United Kingdom produces 1.1 engineers; West Germany produces 1.4 engineers; Japan produces 2.6 engineers; and the Soviet Union produces 4.1 engineers.

PURPOSE AND OBJECTIVES OF THE COMMISSION

The Commission will examine the health and future potential of secondary school mathematics, science and technology education and recommend to the Nation, through the National Science Board, a plan for action. The Commission will seek the advice and assistance of state and local governments, parents, teachers, and other groups and organizations that are specifically concerned with precollege education in mathematics and science. The Commission will also seek the assistance of major professional engineering, mathematics and science societies. These organizations, having memberships numbering in the hundreds of thousands, reach virtually every school district in the United States. The Commission will examine successes and failures in the educational system and will identify the underlying causes. The Commission will propose clearly defined roles that are appropriate for the Federal government, state and local governments, local school districts, private industry, private foundations, and citizens at large.

The overriding objective of the Commission is to translate its activities into a course of action that can be implemented nationwide and that will serve the country long after the Commission completes its work.

LOCATION OF COMMISSION OFFICES

Offices for the Commission are located at the National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550. The offices are in Room 527, and the telephone number is (202) 357-7700.

DURATION OF THE COMMISSION

The Commission is slated to last 18 months, commencing on April 15, 1982, and terminating on October 15, 1983.

REPORTS

Preliminary results will be published after 6 months, with more substantive recommendations at the end of 12 months. The final action plan will be published to coincide with the termination of the Commission (October 15, 1983).

LOCATION OF MEETINGS

Meetings of the full Commission will take place in the National Science Board Room, located at the National Science Foundation headquarters, 1800 G Street, N.W., Washington, D.C. The Commission will hold approximately 10 meetings. It is likely that there will also be some regional meetings involving the Commission or its subcommittees. All meetings will be announced in the Federal Register and will be open to the public. Up-to-date information is available from the Commission Office.

INQUIRIES ABOUT THE COMMISSION

Inquiries should be addressed to Dr. Richard S. Nicholson, Executive Director, Commission on Precollege Education in Mathematics, Science and Technology at the Commission Office.

RELATION TO THE NATIONAL COMMISSION ON EXCELLENCE IN EDUCATION

The Secretary of Education, Terrel Bell, established a National Commission on Excellence in Education on August 26, 1981. Secretary Bell encouraged the formation of a National Science Board Commission to focus specifically on the unique problems confronting precollege education in math and science. The Chairman of the Commission on Excellence, David Pierpont Gardner, also has promised full cooperation. Some National Science Board members have testified before the Commission on Excellence. The National Science Board Commission will work closely with the Commission on Excellence.

NATIONAL SCIENCE FOUNDATION

The National Science Foundation is an independent agency of the Federal government operating within the Executive Branch. The Foundation was established by Congress in 1950 to promote progress in science through the support of scientific research and education. The Foundation is administered by a Director with policy set by the National Science Board. The Director is appointed for a 6-year term by the President with the advice and consent of the Senate. The Director is Dr. John B. Slaughter.

NATIONAL SCIENCE BOARD

The National Science Board was created as part of the Act that established the National Science Foundation in 1950. The Board is the policy-making body for the National Science Foundation. There are 24 Board members, each serving a 6-year term, plus the Director who is an ex officio member. Board members are appointed by the President with the advice and consent of the Senate. The Board annually elects a chairman. The current Chairman is Dr. Lewis M. Branscomb who is Vice-President and Chief Scientist of the IBM Corporation.

COMMISSION MEMBERS

The Commission will be co-chaired by Mr. William T. Coleman, Jr., and Dr. Cecily Cannan Selby.

Mr. William T. Coleman, Jr., lawyer, Secretary of Transportation (1975–77), is a Senior Partner in the law firm of O'Melveny and Myers. He has served as a Director of a number of major industrial and business firms and presently serves as Chairman of the Board of the NAACP Legal Defense and Educational Fund.

Dr. Cecily Cannan Selby, former Academic Dean and now Chairman of the Board of Advisors of the North Carolina School of Science and Mathematics, is a biophysicist. From 1958 to 1972, she taught science and was the Headmistress of Lenox School in New York City. She was a research associate at the Sloan Kettering Institute and the Cornell University Medical College. She has been a trustee of Massachusetts Institute of Technology, Woods Hole Oceanographic Institution, and Radcliffe College. Dr. Selby also served as National Executive Director of the Girl Scouts of the U.S.A.

General Lew Allen, Jr., physicist, is Chief of Staff of the U.S. Air Force. In the Air Force, General Allen has been director of space systems and director of special projects, followed by 4 years (1973–77) as Director of the National Security Agency and Commander of the Air Force Systems Command.

Dr. Victoria Bergin, former Assistant Superintendent of Houston Independent School District, is now Associate Commissioner for General Education, Texas Education Agency.

Dr. George Burnet, Jr., Anson Marston Distinguished Professor, is Chairman of the Nuclear Engineering Department and Coordinator of the Engineering Education Projects Office at Iowa State University. He has been a consultant to the higher education program for India for the Agency for International Development.

Dr. William H. Cosby, Jr., actor and entertainer, holds a Ph.D. in Education. His doctoral dissertation was entitled, "An Integration of the Visual Media via Fat Albert and the Cosby Kids into the Elementary School Curriculum as a Teaching Aid and Vehicle to Achieve Increased Learning."

Mr. Daniel J. Evans, former Governor of Washington (1965–77), is President of The Evergreen State College, Olympia, Washington. Mr. Evans is a member of the Carnegie Council on Policy Studies in Higher Education and a trustee of the Carnegie Foundation for the Advancement of Teaching.

Dr. Donald S. Fredrickson, former Director of the National Institutes of Health (1975–81), is scholar-in-residence at the National Academy of Sciences. Dr. Fredrickson, who has been associated with the Schools of Medicine at George Washington University and Georgetown University in Washington, D.C., is primarily known for his work in cardiology and genetics.

Dr. Patricia Albjerg Graham, former Vice President of Radcliffe College and Director of the National Institute of Education, is Dean-Elect (assumes position on July 1) of the Graduate School of Education at Harvard. Dr. Graham has been a high school teacher and professor of history of education at Harvard. She is the author of two books on the history of education.

Dr. Robert E. Larson, is President of Systems Control, Inc., in Palo Alto, California, and is one of its three founders. He serves as a professor at Stanford University and is also the 1982 President of the Institute of Electrical and Electronics Engineers.

Dr. Gerald D. Laubach, was named President of Pfizer Inc., in 1972. With the company since 1950, Dr. Laubach has held a number of positions with Pfizer, a diversified manufacturer of pharmaceuticals and health care products, chemicals, agricultural and consumer products, as well as products for the materials science industry. Dr. Laubach is Chairman of the Board of Trustees of Connecticut College and a member of the Rockefeller University Council.

Mrs. Katherine P. Layton, is a mathematics teacher, and a former Chairman of the Mathematics Department, Beverly Hills High School (California). She was a member of the College Board's Commission on the SAT Score Decline and a member of the Joint Committee of the Mathematical Association of America and the National Council of Teachers of Mathematics on the decline in preparation of high school students for college mathematics courses.

Dr. Ruth B. Love is General Superintendent, The Chicago Board of Education. She is a former Superintendent of the Oakland Unified School District, Oakland, California. Dr. Love also served as Director, Right-to-Read Effort, U.S. Office of Education.

Dr. Arturo Madrid is a former Director of the Fund for the Improvement of Post-Secondary Education and the Minority Institution Science Improvement Program, Department of Education. Currently, he is on leave from the University of Minnesota, where he held faculty and administrative positions, including Associate Dean and Executive Officer of the College of Liberal Arts. From 1975 until 1981 he served as Director of the Ford-funded Graduate Fellowship Program for Mexican-Americans, Native-Americans, and Puerto Ricans. Dr. Madrid is the President of the National Chicano Council on Higher Education.

Dr. Frederick Mosteller is Roger I. Lee Professor of Mathematical Statistics and Chairman of the Department of Health Policy and Management at the School of Public Health, Harvard University. Dr. Mosteller was Vice Chairman of the President's Commission on Federal Statistics (1970–71) and a member of the National Advisory Council on Equality of Educational Opportunity (1973–79). He was president of the American Association for the Advancement of Science in 1980.

Dr. M. Joan Parent is a veterinarian and is the first Vice President of the National School Boards Association. Dr. Parent serves on the Board of Directors, Minnesota School Boards Association and from 1978–80 was President of that Association. In 1975, she served as President of the Minnesota State High School League.

Dr. Robert W. Parry has been Distinguished Professor of Chemistry at the University of Utah since 1969 after 23 years on the chemistry faculty of the University of Michigan. He was recipient of the Manufacturing Chemists Association Award for Excellence in College Teaching in 1973, and the American Chemical Society

Award in Chemical Education in 1977. He currently is President of the American Chemical Society.

Dr. Benjamin F. Payton, educator, is President of Tuskegee Institute. He was formerly President of Benedict College prior to serving as Program Officer for Education and Public Policy, Ford Foundation (1972–81). Dr. Payton was a member of the faculty at Howard University, and a member of the Visiting Committee of the Board of Overseers, Harvard University.

Dr. Joseph E. Rowe is an electrical engineer and currently is Vice President, General Manager, Harris Corporation of Melbourne, Florida. Dr. Rowe, formerly Dean of Engineering and Provost at Case Western Reserve University is a member of the National Academy of Engineering and serves on the National Research Council's Board on Telecommunications-Computer Applications.

Dr. Herbert A. Simon, social scientist, is Richard King Mellon University Professor of Computer Science and Psychology and a Trustee of Carnegie-Mellon University, Pittsburgh. Dr. Simon was awarded the Alfred Nobel Memorial Prize in Economics in 1978. The thread of continuity through all his work has been his interest in human decision-making and problem-solving processes, and the implications of these processes for social institutions.

Dr. Richard S. Nicholson, Executive Director of the Commission's staff, is on leave from his position as Director of the National Science Foundation's Chemistry Division. Prior to joining the Foundation, he was a chemistry professor at Michigan State University. While at the Foundation he has held several senior positions, including executive secretary for the President's Committee on the National Medal of Science.

More detailed biographical data for individual Commissioners are available from the Commission Office.

STATEMENT OF CECILY CANNAN SELBY, COCHAIRMAN, NATIONAL SCIENCE BOARD, COMMISSION ON PRE-COLLEGE EDUCATION IN MATHEMATICS, SCIENCE, AND TECHNOLOGY

Dr. SELBY. Thank you, Mr. Chairman, and members of the subcommittee.

It is indeed a privilege and a pleasure to be here.

I am Dr. Cecily Selby, Cochairman of the National Science Board, Commission on Pre-College Education in Mathematics, Science, and Technology.

I am happy to have with me today one of our Commissioners, Gov. Dan Evans, former Governor of the State of Washington, and now president of Evergreen State College.

On behalf of my Cochairman, William T. Coleman, and my distinguished co-Commissioners, we are happy to have him here today. I hope that he can participate in the discussions.

I have prepared some information for the subcommittee and would ask that this be placed in the record at this point.

Chairman PERKINS. Without objection, so ordered.

Dr. SELBY. We welcome this opportunity to share some of the committee's research so far, deliberations and plans to date, and will most certainly report to you fully as we move ahead, and move ahead we are surely going to do.

Our findings and recommendations first go to the National Science Board and then for dissemination. Our initial report will be ready very shortly.

Our Commission is the first comprehensive Commission that has been established in the 32-year history of the National Science Board.

Just as the commitment of this committee to 3 days of hearings reflects key policymaking levels of the escalating awareness now clearly including all sectors of society, clearly not restricting the discussion this morning to teachers and classrooms.

But we are talking about the whole of society. Clearly we understand that our Nation's educational systems are facing inordinate difficulty in trying to meet the needs of youth and the needs of the Nation.

The predicament that we face has been so ably summarized this morning by Senator Dodd and by Mr. McGuire.

As a scientist, I marvel to be living in a world where I can even hear over the media of cancer genes, of unified field theory of physics, and violent storms at the bottom of the ocean.

I wonder how those with no understanding whatsoever of the elements can deal even in a society without some kind of understanding like that.

In its deliberations in 1981, the National Science Board determined that the absence of initial consensus on the importance of math, science, and technology in education for all citizens may be the central force.

The lack of a national consensus may be the central cause of what we are talking about here this morning and for the next 2 days.

So, the establishment, the charter of our Commission, is what I have here in my hand. I think you will have access to the booklet. I will not be redundant in describing our mission because it is there.

But, basically, we have the mission to synthesize the information available and to analyze it and to listen and talk to all sectors of the country and all communities to assess what we learn and to plan and then to disseminate.

We are talking, incidentally, when we are talking precollege, that we are not talking college preparatory but we are talking about K through 12.

The Commission's activities have been organized in three phases: The first phase we completed at the first meeting because we have a rather stunning group of leaders from academia and government and military and business all represented on the Commission. We certainly have teachers on the Commission.

The readiness with which a clear-cut consensus came at the first meeting on the statement of the problem bodes well for our work from then on.

Overall, we decided that the goals that we have for the U.S. educational system—and I am talking about formal and informal—that they are three equally important interlocking and sometimes parallel goals for the system.

These goals then become the goal of our Commission. First, they continue to develop a pool of students who are well prepared and motivated for the advanced careers. I think there is no need to elaborate on that.

By broadening the pool, we mean to bring into the pool our most highly motivated and most highly prepared students for the cutting-edge work of the future and bringing into that pool a broad economic representation with minorities and women.

We want to broaden the pool because we need all the talent that we have at this point.

To widen the range, we have the second goal, which is to widen the range of high-quality offerings in math, science, and technology so that most students will have the option of choosing technically oriented careers and professions.

Recognition of the critical importance of this task has become more widespread in the last 2 years.

The gap between opportunities for those with and without broad credentials and math and technology is likely to increase along with the complexity of society.

So in our second goal, we are dealing with the broad manpower of human resource needs of the Nation.

The third goal is to raise the general science and technology literacy of all citizens to prepare them to live, work, and participate fully in the society of the future.

You can say that the challenge implicit in this third task is translating into contemporary terms the Thomas Jefferson familiar dictum that:

"An educated citizen is the only safe repository of democratic values."

The central conclusion of our analysis to date—and the Commissioners have been working across the country over the past few months independently and in various task groups—is that although there are many localities with the capacity to reach the first goal, we still have superbly trained scientists, mathematicians, and engineers.

However, they need help to maintain and broaden this capacity.

But our system in the aggregate with notable exceptions always lacks the capacity to achieve the second and third goals. That is the broad strengthening of education of everyone and raising the scientific literacy of the total population.

What is our evidence here? I am not going to go into statistics because you have access to so many and have heard so many and will hear so many.

Primarily as a Commission we are focusing on the declining student achievement and participation at a time of increasing national need.

That is just at the time that we need more and we are getting less.

I would like to tell you one story. I know several institutions well, including MIT. I do not think any of you would think of MIT of having to go into remedial courses.

But they have had to, because of the declining qualifications brought to them in the freshman class from their high schools, they have designed an alternative chemistry course to satisfy the undergraduate requirements.

That chemistry course requires less preparation and achieves less than the previous MIT chemistry courses.

To move ahead then, the Commission has already identified a host of problems that contribute to this overall phenomenon of declining student participation and achievement.

The most obvious ones relate to teachers, classrooms, curricula, instructional approaches, and overall what is being called time-on-task. I think you are going to be hearing more about time-on-task. That is the time in the schoolday and the school week and the school year that is spent on any aspect of math, science, and technology.

I do not think anyone is going to come before you and tell you that it is enough. It is low, low, low, compared to any criteria that you might want to consider.

With respect to curricula, there are serious doubts as to whether many of the commonly offered math, science, and technology courses in the secondary schools are, in their present form, of much value to students who are not planning careers in math, science, and technology.

These courses are perceived as difficult and schools often try to keep students out of these courses rather than get students in.

I think all of us here this morning want more students in math, science, and technology and not a sieve to keep out all those who are from the most motivating backgrounds.

Since 1970, as you know, there has been a nationwide trend toward reduction of high school graduation requirements. Only one-third of the 16,000 school districts require more than 1 year of math and science.

At the same time, colleges and universities have reduced the amount of math and science that they require, as I mentioned before.

Certainly exacerbating the problem is the severe and growing shortage of math and physical science teachers as has been so beautifully summarized by Mr. McGuire.

With all of these problems—and you certainly are going to hear a litany of them—we believe as a commission there is a broad consensus already that the schools themselves are not the root cause of the predicament.

To a large extent, public schools reflect public perceptions and priorities as much or more as they determine them.

Parent problems with student participation and achievement rely on underlying societal belief that although it is important to prepare the most able and self-motivated students for college work, course work in these subjects beyond the minimum is unnecessary for and irrelevant to the vast majority of students.

This seems to have been the perception over the last generation and it is consistent with another view that although excellence in science is vitally important to the Nation, it can and should be left to the experts, those people who do understand or know what RNA stands for, if you will.

So, following this type of analysis, which is where the Commission has been so far, we are now into the second phase which we call identification and analysis.

We will have our second meeting of the Commission in a couple of weeks and then another one in December and another in January.

The Commissioners are meeting in task groups that have been organized to reflect the following very broad categories of those involved in the educational puzzle.

You have the policymakers and the Government representatives and the direct hands-on educators, teachers, and administrators. There is a group called facilitators, those groups who can help the whole educational process.

We have the business, higher education, the media, and the military.

There are also the employers, those who must deal with the product.

Again, we have the business, higher education, and the military.

Through these task groups which are now also adding other experts and other representatives, we are examining existing programs around the country.

We are identifying the exemplary programs that have the potential of adaptation to other communities. We then will have a base of information from which we will come to our action timing stage in 1983.

Thus, to summarize, although the Commission is a working body still only 3 months old, we have learned much. We have learned and we call it a predicament and not a problem. A problem usually assumes an easy single solution. A predicament is a complex situation that does not require a single solution. It requires dealing with it.

The predicament we face is not solely the fault nor its remedy, but is solely the responsibility of any one sector of society.

I think Mr. McGuire's comments support this view very strongly.

The solution to the predicament will require major efforts by all sectors including government at all levels and educators and private industry and professional associations and very importantly the science and technology community itself.

If we ever solve this, we will help to develop partnerships. I am thrilled to have heard so much already this morning said about partnerships.

I think the partnerships between the legislators and the practitioners as exemplified by this hearing are just another type of partnership that we are all developing.

Second, it has become clear that we should not focus solely on secondary schools. I thank Congressman Goodling for bringing up the elementary school. It is key.

It all starts at the elementary school and the junior high is the place that most students make career choices and high school and college choices and vocational choices.

Third, as I have suggested, we must focus both on our formal and informal educational systems. Much is learned about mathematics, science, and technology outside of the classroom. It is very successful currently outside the classroom.

The media and museums and voluntary youth agencies are partially responsible for that system.

This is a very successful and unique part of the American scene. We must capitalize on it.

Finally, there are some thoughts on technology. It has become clear that very little, if any, technology is taught at the precollege level.

There are few, if any, courses devoted exclusively to technology. I mean the applications of science to society and the effect of society and science and applied science itself, preengineering, if you will.

Our courses in science and math devote little of their time to technological developmental issues. We already feel that this is a major aspect to be looked at.

Technology, in addition to being a subject for study, provides a marvelous tool for the educational process. Technologies can be used both as a teaching device—we all know about computer-aided teaching, which is a vehicle for bringing math, science, and technology to broader populations, as in video discs and video tapes and video texts and telecommunications and so on.

It is noteable to me that both the British and French, for starters, have made major commitments at the top levels of their systems to improving the productivity of the classroom, if you will, and the literacy.

I would like to include science and math into the literacy. The literacy of the students can be improved by the judicious use of technology.

Although there is much to be done, there is much that already has been done. Everytime we turn around we find some exemplary programs. We look forward to bringing these to national attention and indicating areas where development should and could be made.

It has been a privilege to report, even though this is preliminary, on the Commission. As a Nation we have superb resources of people and technology to come to the sense of this committee.

Clearly the help and counsel of our best minds and hearts and our political, economic, and intellectual leadership are needed to energize, to mobilize, and to allocate and reallocate, if you would, the resources that we have to better serve our citizens.

As a postscript perhaps to a word on the Commission, I thought you would be interested in my personal perspective as a scientist and as an educator.

I am a person who was brought out in an academic and scientific community. I concentrated early in my graduate studies in math and physics and in biology.

I had the joy and privilege of working myself at the cutting edge of biophysical studies of normal and cancer cells for 10 years before I moved, for family reasons, to head a small K through 12 independent school for 13 years and then to serve as national executive director of the Girl Scouts.

Most recently I was called in to consult on academic planning for the North Carolina School of Science and Mathematics. I know the chairman is familiar with this. It is in Durham, N.C.

I served as academic dean of the school for its first year operation and now chair its board of advisers.

If any of this experience would be helpful to you, I would be happy to speak to it.

But what I really want to share with you is that as a scientist, my overall concern is that we are not turning on youth and adults alike to the love of science and mathematics.

But those of us who have had the good fortune to have lived in this world so much want to share, that kind of understanding and bringing students confidence and it brings them a skill and a problem solving.

It brings people more windows on the world and a broader vision of the world in my view. That is what science and math has to offer to all of us.

Much of the fault of my personal view lies in us, the scientists, not seeking the help to communicate the essence of science or math or technology more fundamentally.

I do not know how it is possible to get the flavor of science without having had years in research at the desk or at the lab bench.

But we have to find ways to do it. Instead of that, we are communicating something that is very dull and factual and made to sound very difficult.

Through the work of our Commission we must and we will—and we already are—addressing the issue of what is the math and science that deserves to be and that people deserve to hear about.

How better to talk about it and how better to interpret it than to do this?

Chairman **Perkins**. Excuse me; I am going to have to interrupt you at this point. But let me say this.

All of you keep in mind the predicament we face at the local level and in our local school districts. The fact is that some of our local educational boards do not have the financial resources to pay the salaries that are necessary to hold good teachers.

Even with Federal aid, it seems that teacher salaries have stagnated in certain sections of the country.

It has been brought out here this morning that we are in competition with private industry.

I think we must address those issues if we are going to sell this type of legislation to the Congress of the United States.

We will be back to you in a few moments, Dr. Selby, to let you finish your recommendations.

Senator Hart, we are delighted to have you with us today.

We appreciate your coming today.

You may proceed.

STATEMENT OF HON. GARY HART, A U.S. SENATOR FROM THE STATE OF COLORADO

Senator **Hart**. Thank you, Mr. Chairman.

I want to thank you, Chairman Perkins, and the other subcommittee members for giving me the opportunity to be here this morning to discuss the American Defense Education Act.

I apologize for interrupting the flow of witnesses that you had here already.

The chairman has introduced an almost identical measure in the House of Representatives and I look forward to working with him on this joint effort.

Introduced in June, it is my hope this bill can help refocus national attention on the relationship between investment in education, and America's economic and national security.

We all recall, and I think interestingly enough it is 25 years ago next week, the launching of Sputnik in 1957 and the fact that it awakened the Congress and the American people to the urgency of strengthening and encouraging education in the fields of mathematics, the sciences, and foreign languages. Congress responded with the passage of the National Defense Education Act.

It is imperative in 1982 to again acknowledge the economic and national security of our Nation depends on the education and the training of our people. In fact, this includes our work force.

The American economy is undergoing a profound transformation—as far reaching and pervasive as the industrial revolution.

That revolution turned a nation of farmers into a nation of factory workers.

In 1982, America is fast becoming a nation of workers with words and information. The opportunities for jobs, for growth, for prosperity in the 1980's and 1990's depend on our human resources even more than our physical resources.

A major step in that direction must be a renewed emphasis on mathematics, the sciences, foreign languages, communication skills, and new technology.

The American Defense Education Act can be an initial step by encouraging local school districts to revitalize their curricula in these vital areas.

Specifically, any local district desiring to participate, under the terms of this legislation, develops and implements its own program.

It must include an assessment of present instruction and student achievement and plans for improving instruction in mathematics, the sciences, and the other areas I have listed.

During each fiscal year, school districts working with the ADEA program will be entitled to a basic payment of 2 percent of the average per pupil expenditure in the State.

And, for those which can show substantial evidence the program meets the ADEA goals for the year, an additional 2 percent payment is available.

To measure each programs' progress, local school districts are to establish yearly evaluation systems including participation from the school board, administrators, teachers, parents, the appropriate bargaining agent, business, and industry.

Administration of the program correctly lies with the Department of Education. However, the bill requires the Secretary of Defense to project personnel training needs for the Armed Forces for the following 4 years, and, in conjunction with the Secretary of Education and local school districts, prepare an analysis of the educational requirements of the Department of Defense to assist in efficient personnel development.

Let me elaborate on this last point.

Today's defense rests on sophistical equipment, whether we like that or not. This equipment incorporates the most up-to-date science and technology, and, in many cases, future technology.

But, the equipment is worthless if we do not have the minds to control it, to operate it, and maintain it. Unfortunately, many of our troops cannot even read the instruction manuals.

The Defense Department spends millions to rewrite the manuals, from the 11th grade reading level to the 6th grade or lower.

Eventually equipment and training manuals become obsolete and are discarded, costing our Government millions of dollars.

By encouraging local school districts to revitalize their curricula in mathematics, the sciences, communication skills, and new technology, we invest in the knowledge necessary for defense in a technologically advanced age. Our national security rests on making that investment.

I think the important point I want to emphasize here is that we cannot, in a society as sophisticated as ours, consider dollars invested in the education of young people and citizens generally as dollars that are competing with military dollars.

That kind of nearsightedness, I think, has caused us some of the problems we have, for example, in NATO today, of retaining the kind of forces with skill levels necessary to defend this country.

Technological and scientific knowlege is also necessary to meet our economic objective of successful international competition.

However, in recent years, we have paid less attention to training in math and science while our toughest international competitors pay more.

We see the number of engineers and engineering teachers declining in this country, while in almost every industrialized nation in the world, those numbers are going up. That is not accidental. It is because those countries are investing in those skill levels.

In his article entitled "Investing in People," Howard Samuels states:

> Russia, our political competitor and Japan, our economic competitor, are spending billions to capitalize on their youth's potential.

In the Soviet Union:

> Every student receives ten years of mathematics, five years of physics, four years of chemistry, five and a half years of biology, five years of geography, three years of mechanical drawing, and ten years of workshop training for both boys and girls.
>
> Meanwhile, the Japanese are pursuing a similarly intensive scientific training program and achieving astounding results. Japan now graduates as many engineers every year as the United States—

This, if I recall, is with a population well less than half of ours—and Japanese students score the highest in the non-Communist world in math and science.

Unless we better prepare our children in mathematics and science, we will not be able to compete successfully in the international market place. Our economic future will be jeopardized.

The American Defense Education Act establishes an incentive program which is necessary to give needed Federal impetus to enable our country to meet the demands placed on our educational systems by the technological changes taking place in today's world.

It is vital to our economic well-being and to our national security that the Federal Government provide the incentive to local school districts to develop the program which will train our young people for tomorrow's world.

Thank you very much.

I apologize again for interrupting the proceedings.

Mr. **Miller** [acting chairman]. Mr. Kildee?

Mr. **Kildee**. I want to thank Senator Hart for being here. I urge him to come back to Michigan and speak to us again in Michigan.

Mr. **Miller**. Mr. Goodling?

Mr. **Goodling**. I want to express my appreciation to Senator Hart for testifying before us.

As I indicated when Senator Dodd was here, we have a lot to do in this area. One of my concerns, as I expressed at that time, is that we make very sure that we start on the elementary level.

We have a great deal, probably, to do on the Federal level with modern math all of a sudden descending on the schools and reading without phonics and so on.

But one of the problems was to the elementary teacher that was a frightening experience because, of course, probably that elementary school teacher had two math courses in college and two science courses in college, one of which, unfortunately, was how to teach math or how to teach science.

So they really only had one math course and one science course. They had to rely strictly on what they learned in elementary and secondary school in mathematics in order to teach mathematics in the elementary school.

So, we gave them a couple of workshops which was fine for the secondary math teacher who was trained in math. But unfortunately for the elementary teacher, it confused them even more.

I am not sure what the damage was, but it was not because modern math—which was not modern at all; as math teachers would say, it was what they always had done and learned.

So, whatever we do in these programs, I hope we really consider what must be done on the elementary level in relationship to the elementary teacher who, somehow or other, is supposed to be able to teach all subjects very well.

Dr. Selby indicated that we were getting fewer people in more sophisticated math and science programs and we should be getting more people in those courses at the secondary level.

The problem I discovered in the business was the better trained that math and science teacher was, the more inclined that math and science teacher became to want to teach the very gifted in those particular areas.

This reputation spread and the youngsters stay away from these kinds of programs.

I did not have too many teachers who taught the slower learner equally as well as they taught the fast learner.

So, I hope anything you do on the Senate side and anything we do on this side, we really take a look at the training of that elementary teacher, if we are going to make a difference.

We cannot wait that long, but we have to do both at the same time, in my estimation, or we will not be successful.

Senator HART. The Congressman's point is well taken. Even if the legislation, which I am here promoting, were to pass today, I think we have a considerable amount of additional work to do in terms of preparing and expanding the teacher work force for the future.

I think the point you have made is an excellent one.

Mr. MILLER. Mr. Erdahl?

Mr. ERDAHL. Thank you very much.

I want to thank the Senator for being here. We heard from your colleague earlier, expressing concern in this area.

One of the things that struck me is this. Maybe we need to be startled by these figures.

When you make the comparison—and this was on page 5 of his prepared testimony—there is the dramatic difference on the comparision of the technical studies in terms of our political competitors and economic competitors.

In the Soviet Union maybe they have more latitude to set national policy at the Federal level than we do in this Congress.

But it seems obvious from what is happening there, that there had been established a national priority with an emphasis on these areas.

I cannot help but wonder that maybe they are leaving some things out. Yet I think in the public schools in Russia they are taught history and they have a great love of their country and music.

I am assuming maybe they are not neglecting these studies either.

So, it gives us proper cause for concern. Maybe with the mood of the Congress and the country, that would be the lever that we should try to use to jar us out of a situation that has grave security dangers apart from the deprevation that some of the young people have from not being exposed to these areas.

Would you care to elaborate on that?

Senator **Hart**. You are right. Unfortunately, our society is such that particularly now when we are living in troubled times, and unlike perhaps in the late 1950s, that we tend not to focus on fundamental societal problems until we are shocked into it.

I think the 25th year anniversary of the launching of sputnik next week might be an appropriate time to think about what the mood of the country was when we woke up one day and literally could see, with some assistance, the Russian object floating over our heads.

We knew they had not done that overnight, as it were, but there was an awful lot of investment in technology, science, training, and education to get to that point.

I would hope next year or the year after that there is not some fundamental breakthrough on the part of the Soviets, Chinese, or someone else that shocks us once again to try to play catchup, which is exactly what we did in the late 1950's and the 1960's.

I think probably we caught up. But we are not governing in a period of slack. Instead of planting our seed corn, we are eating it.

It seems that you cannot cut back on aid to education, on scholarships, on student loans, and on a fundamental national direction for a better trained work force and expect to compete with other nations that are doing exactly the opposite.

I hope we do not have that kind of shock that we had with sputnik to wake us up.

Mr. **Erdahl**. I made the same observation. I hope we would not have to have a similar international shock to jar us loose, but it does not seem we are moving in that direction.

One other panel member before you referenced that we are spending $1.6 trillion or $1.9 trillion over the next several years for our Military Establishment.

I believe I heard some place that if you translate that into more understandable dimensions, it comes out to about $36 million an hour that we are projecting to spend.

I think something like this should remind us, the country, and the Congress, that we have some of our priorities out of kilter.

Do we find our security only in the military hardware or do we have it in trained, competent people?

In my mind it rests with the people rather than the armaments. We need to tilt it back in that more sensible direction, in my view.

But anyway, thank you very much. I thank the Chairman.

Mr. **Miller**. Mr. Petri?

Mr. **Petri**. Thank you, Mr. Chairman.

I want to make one or two comments and then ask a question.

I was struck by the fact that private companies and other noneducational organizations seem to be ahead of the educational system in this country in using new teaching technology and in training the personnel.

I am not sure what the reason for that is, but it seems to be the case. Maybe there is something we could be doing at the Federal level to help.

I would like your comment on this, Senator. We had hearings some months ago where people who had done studies came in and indicated that one big variable in the quality of education, or the performance of students in similar schools, seemed to be the leadership of the principal.

We know the FBI has had programs for years to provide courses for police personnel around the country and other Federal institutions have done similar things.

This might be one area where we could, as a Federal Government, either encourage graduate schools or make some funds available on a matching basis for States especially small States who could not otherwise do it very well, where principals or candidates to be principals or leaders in local and State education could go for 3 months, 6 months, or whatever, for a course and upgrade their leadership skills.

That could infuse itself and have a big multiplying effect with relatively small dollars.

Do you have any reaction to that?

Senator **Hart**. That is an insightful and interesting observation.

The witnesses here today are professionals and I think they could address that much better than I.

I think that as an amateur student of human nature, you have touched on a central point and that is, leadership for the individual given the principle responsibility for administration and guidance, that is, if that is an innovative and creative and imaginative person, then by osmosis and in the operation of human institutions, it would seem to filter out to the teaching force and then eventually to the students.

I have no magic solution. I think the idea of perhaps specialized training or leadership training for potential and actual principals may be a good idea.

Certainly the bill I have proposed does not include that but it certainly could very easily.

Mr. **Miller**. Senator, we want to thank you for your testimony. Let me ask one question. My concern, and our concern, about whether we are training engineers and/or scientists come to this:

In your testimony you talk about the problem that the military has with respect to whether or not those students can read those sophisticated manuals that go along with sophisticated weapons.

I do not know if that person needs more technical education since we take people with a high school education, but maybe they need a good base in reading.

My concern is that you have a significant portion of the population which appears to have neither the choice or the opportunity to make the choice to pursue science or mathematics.

They are foreclosed at an earlier level. They do not have the ability to make that choice after high school or even during high school because of the failure of the system to give them a base in reading and in very fundamental math.

We are not talking about sophisticated mathematics.

Students need to be comfortable to make the choice and take the next step in pursuit of an education in math or reading.

It seems to me that we have to back up quite a ways down the line in order to determine where the failure occurs.

It does not seem to me that it is at the level where the student is making the choice of whether or not to go from physics to advanced physics.

It seems to me that the problem is generational down the line when the student either was properly taught and skilled in the building blocks that would lead him to the decision to take physics I.

Most of the students decide they cannot because they are so unsure of their fundamentals in mathematics. Students decide they would not take another language because they are so unsure of their skills in the English language.

That sounds to me like a basic fundamental educational problem or a predicament, as one of the witnesses used earlier.

We focus on that we want to create an engineer or a scientist. It seems to me what the Army needs is people who can read.

Senator HART. To a degree your question is better directed, or at least could be better answered by the professionals at the table with me.

As a layman, and perhaps even as a father, I can comment. My teenage children do not read nearly as much as I did at their age or as I do now.

There have been all sorts of explanations as to why that is and quite often they end back up at the footstep of television.

I suspect at least in their case that has a lot to do with it. I think it is deplorable for a whole lot of reasons. I do not know how you do anything in life without being a reader.

Something has to be done, whether through increased funding from the Federal level to institutions or a different kind of institutional setup or a different priority in terms of fundamentals at an early stage, or whatever. You have to put your finger on the point.

I will comment as a member of the Armed Services Committee, however. This is called the Defense Education Act on purpose, both to make a point of having to do with its predecessor 25 years ago and to try to more fundamentally make the linkage that I was trying to make in my prepared testimony and that is that up here in the Congress you talk about priorities.

We now are in a situation where we are trying to decide that we are taking money out of human resources and so-called domestic programs and putting them into defense.

Does that make any sense if you have the increasingly notorious M-1 tank where I am told, as a member of the Armed Forces Committee, not only as I indicated the operating manuals have to be rewritten down so they can be read, but even after they are read the people cannot run the equipment?

It is a dual problem. It is writing so they can read and then once they have read it, knowing what to do about it.

Mr. **Miller**. There was also the suggestion that, in fact, textbooks are being written down so people can read them. The fourth grade level is different than the sixth grade level of proficiency and so on.

Whether that is true or not, I do not know, but it seems to me that we are dealing with a fundamental nature of the problem before we can leap to the forward idea of whether or not we have an engineer or a technician.

We are precluding that choice at an early level.

If there are no further questions, Senator, we thank you very much for being here.

Dr. Selby, I think we interrupted you.

Dr. **Selby**. I was just about to finish.

In recognition of the comprehensive nature of the problem, the Commission is reserving its recommendations for a final report in a year.

But we will be having preliminary reports as we move along which will be shared with you.

I was emphasizing the pieces that we see already as being important. The elementary school was one and the partnerships were another and technology was another.

I was closing with some personal comments of mine that I still would like to emphasize and that is on the long range, if we can only find the ways to better talk about science and mathematics, then I think this would turn on the students and teachers and the communities.

A lot of what we were talking about now will find its own solution.

But we need to be doing that on a parallel track as we all work with some of these short range solutions and short range partnerships between the scientists and the educators and between the technologists and the educators at all levels.

Certainly the types of short-term solutions that we have seen so far are working very well.

Thank you very much. I do not know whether you would like to give Governor Evans a chance to give a postscript, but I thank you.

Mr. **Miller**. Mr. Evans?

We are delighted you could be here with us today.

You may proceed.

STATEMENT OF DANIEL EVANS, PRESIDENT, EVERGREEN STATE COLLEGE, STATE OF WASHINGTON

Mr. **Evans**. Thank you, Mr. Chairman.

I will be "Tail-End Charlie" to Dr. Selby.

As a member of the Commission, I have an interest in relationship to the Commission as one who received a graduate degree in structural engineering and served as 12 years as Governor of the State of Washington, and who is now president of the Evergreen State College.

I think the most important postscript I would like to add is just what is different about today from the era of sputnik, or a past even closer to the present than the time of sputnik.

It has been pointed out by a number of people that three-quarters of all of today's knowlege of human kind has come in the last 20 years.

That perhaps dramatizes more than anything else the difficulty we face. In fact, in our State, just recently I read a comment from a very young computer whiz who had the arrogance, I guess, but probably shared by some of his colleagues, by saying that anyone born before 1965 was irrelevant.

That was to point out that generally those who were born at an earlier stage, or the precomputer generation, found it uncomfortable to get acquainted with and understand the computer and communications revolution in which we are living.

To dramatize the problem, the teaching corps of today, that is, those who are in our colleges and universities who are choosing to be teachers represent the very lowest SAT scores of any of the major disciplines or even the minor disciplines being taken in our colleges and universities. That is tragic.

But more importantly, the current teacher corps in mathematics and in science, to a degree, are teachers who were trained in a different era.

We had testimony at our first meeting from one of the top mathematic educators in the country who said that the basics of mathematics are no longer what they were and that new kinds of basics need to be taught.

But most of our current teachers were taught different basics and are teaching yesterday's basics for today's mathematic needs.

So, it is a massive retraining job necessary promptly as well as a job of attempting to re-encourage new, young teachers to extend our teaching corps.

The equipment increasingly necessary for adequate education simply is not in the budget of most primary and secondary schools, and even the colleges and universities of our Nation.

I have one final comment.

With all of this emphasis on math, science, and technology, I fear for the future of our country if that is only where we specialize.

It will not do much good if we have computer whizzes and scientists galore and no one with the communications ability and the writing ability and the opportunity for clear and logical thinking and the sense of proportional history and the humanities which in many respects are the glue which holds our society together.

And perhaps most of all not just the teaching of specific subject matter is there, but with the explosion of knowledge, perhaps the best single thing we can provide in our educational system is the means for a graduate to know how to logically and continuously and in an organized fashion continue to acquire necessary knowledge to keep up with the rapidly changing society.

That is all I have to say at this time.

Thank you.

Mr. MILLER. Mr. Erdahl?

Mr. ERDAHL. Mr. Chairman, I want to thank the Governor very much for being with us today and for his patience and in waiting his turn to share his observations with us.

I think what you said is very relevant. Not that we should not stress the teaching and learning of the technical subject, but we should not forget the other ones that have an impact on our society and on humanity itself as well.

I do not know if you were here, Governor, when I was mentioning about the startling facts and the Senator's comments about the Soviets and what they are doing.

I am reminded of our son who takes music lessons from a Russian Jew who left that country a few years ago—about 5 years ago. He has a deep, melodious voice. I have met him.

And as he says: "Russian music is very beautiful. Russian politics is very bad."

So, we must not forget the emphasis in this area.

I asked a teacher once what she taught and she said: "I teach kids."

Maybe that is the important thing that we should ignore in striving for excellence. We should not ignore that. We must remember in the technical fields that we teach not only subjects but we teach people.

I think you have given the proper emphasis there this morning. I appreciate your underscoring it and highlighting it for our attention.

Thank you very much.

Mr. MILLER. Mr. Goodling?

Mr. GOODLING. These do not necessarily fit in with what the Governor said, but I have a couple of observations.

We have two different committees going on at the same time which makes it very difficult up here. But let me say this.

We have to keep in mind that one of the few countries where so much emphasis is placed on educating the masses, particularly in the last 30 years, is our country.

I can even think back when I graduated from eighth grade when we had to take the county examination to go on to the ninth grade in the city.

Many people who now are involved in public education processes never came to school at all. So that is something we have been doing that many of the countries have not been doing.

My second observation is this. As I was listening to what we need with relationship to teachers, I was stressing the elementary level before.

But as I think of the graduate courses that I took, I am trying to think of who those outstanding professors were whom I had in those 90 courses.

Those outstanding professors, unfortunately, in many instances, will teach 3 hours a week, if they have to. But research is the name of the game that they are primarily interested in.

So many times you do not even have the opportunity to get the outstanding professor on the college level in teaching.

Also, we have to make sure that in a time of scarce resources that we do not go off half cocked. We must not think that we can just throw money at the problem and it will solve it.

Last week we had four superintendents from across the Nation here. Without exception, the first three said if they had more money, then they really could do the job.

The fourth one had rewarding testimony for us because she indicated that she would like not to have any more money taken from her, but she spent most of her time testifying about the innovating things they are doing in an area where you might not think this would take place and how they have reached out to the private sector and brought them in on this situation.

In the long run, of course, they benefit the most from a better program in her schools in the first place.

I thought it was such a refreshing bit of testimony. We must make sure that as we feel our way through this program and the problems that we are facing that we really know what we are doing when we move ahead, attributing scare resource situations as the reason.

We do not want to throw money at the problem and think the problem will go away.

Thank you very much.

Mr. Miller. Mr. Forbes; we welcome you here today.

Please proceed.

[Prepared statement of Roy Forbes follows:]

PREPARED STATEMENT OF ROY FORBES

Nurtured by the fruits of technology, our country is entering an innovative phase of industrial and human productivity. The demand for new products reflects the accomplishments of the age of electronics.

The type and quality of one's skills are and increasingly will be crucial factors in determining the degree of one's employability. As economist David Stout has noted,

> Many existing skills, such as traditional information handling, typing, automobile maintenance and mechanical engineering, will be a glut on the market, while numeracy, quick-wittedness, and fluency will be at a premium".

Only a few decades ago, a skill acquired at the beginning of one's career was expected to maintain its economic relevance until retirement. Now, some experts predict that the life expectancy of a skill is ten years or less.

High technology industry in the United States is currently a multi-billion dollar enterprise and includes such fields as information processing, electronics, machinery, aerospace, energy, mining, instruments and biotechnology. Spurring along the research and manufacturing of high technology products is intense national and international competition, in spite of current economic growth obstacles.

There is no sign that computer growth has yet reached its limit. The new technologies of tomorrow are potentially richer than any previous technology due to their scope, safety, speed, diversity, lower energy needs and reduction in size and costs. The "growth" industries of the future will be formed by the outgrowth of the new technologies, creating an increasingly sophisticated American industry.

The fastest growing occupations through 1990, as targeted by the Bureau of Labor Statistics, include workers such as data processing machine mechanics (148%), computer systems analysts (108%), computer operators (88%), computer programmers (74%), and aero-astronautic engineers (70%).

The fastest growing occupations are not expected to account for the majority of jobs throughout the 1980s. In the following table, the Bureau of Labor Statistics presents the occupations that will account for 50 percent of all new jobs generated during the 1980s.

THE FOLLOWING OCCUPATIONS WILL ACCOUNT FOR 50 PERCENT OF ALL NEW JOBS GENERATED DURING THE 1980'S

OCCUPATION	GROWTH IN EMPLOYMENT 1/ 1980-90 (IN THOUSANDS)
SECRETARIES	700
NURSES' AIDES AND ORDERLIES	508
JANITORS AND SEXTONS	501
SALES CLERKS	479
CASHIERS	452
NURSES, PROFESSIONAL	437
TRUCK DRIVERS	415
FOOD SERVICE WORKERS, FAST FOOD RESTAURANTS	400
GENERAL CLERKS, OFFICE	377
WAITERS AND WAITRESSES	360
ELEMENTARY SCHOOL TEACHERS	251
KITCHEN HELPERS	231
ACCOUNTANTS AND AUDITORS	221
HELPERS, TRADES	212
AUTOMOTIVE MECHANICS	206
BLUE-COLLAR WORKER SUPERVISORS	206
TYPISTS	187
LICENSED PRACTICAL NURSES	185
CARPENTERS	173
BOOKKEEPERS, HAND	167
GUARDS AND DOORKEEPERS	153
STOCK CLERKS, STOCKROOM AND WAREHOUSE	142
COMPUTER SYSTEMS ANALYSTS	139
STORE MANAGERS	139
PHYSICIANS, MEDICAL AND OSTEOPATHIC	135
MAINTENANCE REPAIRERS, GENERAL UTILITY	134
COMPUTER OPERATORS	132
CHILD CARE WORKERS, EXCEPT PRIVATE HOUSEHOLD	125
WELDERS AND FLAMECUTTERS	123
STOCK CLERKS, SALES FLOOR	120
ELECTRICAL ENGINEERS	115
COMPUTER PROGRAMMERS	112
ELECTRICIANS	109
BANK TELLERS	108
ELECTRICAL AND ELECTRONIC TECHNICIANS	107
LAWYERS	107
SALES AGENTS AND REPRESENTATIVES, REAL ESTATE	102

/ LOW ALTERNATIVE ONLY

OURCE: BUREAU OF LABOR STATISTICS

The occupations presented in the table cover a range of industries and do not fall exclusively within the high technology sector. Because of the enormous advantages offered by high technology products, however, it is not unreasonable to suggest that they will radically alter the skills necessary for the performance of these jobs. For example, many of the occupations listed in the table (secretaries, cashiers, hand bookkeepers and stock clerks, for example) have already felt the impact of word processors, computerized cash registers and inventory control equipment. As the cost of microcomputers continues to plummet while their diverse applications increase, a majority of future jobs will depend on workers with flexible skills who can adapt to the technology.

The paramount conclusion evidenced by the growth in traditional occupations, as well as by the new jobs generated in high technology industries, is that the skills required for future employment will be different than those of today. Our nation's future economic productivity and security depends on how quickly and how well we can prepare tomorrow's workers for this inevitable development.

A typical job description in 1990 will likely include many tasks such as these:

1. Operate various computer and peripheral equipment.
2. Prepare input for and execute utility programs.
3. Maintain files of technical information and verify the correctness of file input.
4. Monitor work flow of production systems.
5. Participate in the enhancement of system and development efforts.
6. Interface with other departments about possible enhancements and determine computer program errors.
7. Provide technical liaison and assistance to users.
8. Evaluate and maintain new software/hardware.
9. Provide training in above tasks for less experienced personnel.

This list is by no means exhaustive and not intended to represent the job level of every future employee. Tasks such as these, however, will become more widespread across all industries. Obviously the more technical the job, the more on-the-job training that will be required, but education systems can provide essential preparation for the workplace. Students lacking minimal skills can expect to encounter stiff competition for employment and advancement in the labor force.

Because education is so vital for employment, identification of the minimum skills required for self-sufficiency in our society has become a prominent education issue. The previous decade witnessed the birth of the "back to basics" movement in our nation's schools. Agreement upon what is considered basic is not universal, however. To one group of educators, the basic skills are defined as "life" or "survival" skills, such as reading a parking ticket or filling out an income tax form. Another group of educators claim that it is the schools' fundamental responsibility to acquaint our nation's youth with a diversity of knowledge in the arts, humanities and sciences, for instance, so that they will be prepared as adults to challenge any opportunity they so choose. The issues of minimum competency and functional literacy have provoked heated debates over education philosophies, levels of funding and school curricula. Thirty-six states have implemented Minimum Competency Testing Programs covering the basic skills of reading, writing and mathematics.

Further confounding the issue is the fact that definitions of what is considered basic do not remain constant over time. Levels of literacy have risen in the United States throughout the past century. For example, previous definitions included a demonstrated ability to sign one's name (colonial measure) and a self-proclaimed ability to read and write. As will be reviewed in the following section, substantial progress has been made with the "minimum" level in the traditional basics, especially for minority and disadvantaged children.

The data base of National Assessment of Educational Progress is particularly well-suited to describe the educational attainments of students for a broad range of literacy definitions. Not only do the assessments cover the full range of contents taught by our nation's schools, but learning areas are periodically reassessed so that improvements or declines in achievement may be measured. A single assessment includes both easy and difficult items; thus results yield information for minimum skills or for those skills considered to be of a higher level. Keeping the description of tomorrow's labor force in mind, what does National Assessment data say about the preparation of high school students as future workers?

There is growing consensus that the "basics" of tomorrow will be the skills that today are considered to be of a higher level. These skills include:

- Evaluation and analysis skills
- Critical thinking
- Problem-solving strategies, including mathematical problem-solving
- Organization and reference skills
- Synthesis
- Application
- Creativity
- Decision-making given incomplete information
- Communication skills through a variety of modes

The question, then, is how well are we doing on these new "basics"?

Reading

Low Level

- In a 1976 study, National Assessment found that 87 percent of the nation's 17-year-olds could perform reading tasks designated as functional by the Right-to-Read program.
- In the 1971, 1975 and 1980 reading assessments, the average proportion of 17-year-olds correctly answering

questions requiring literal comprehension was 72 percent. Literal comprehension involves locating or remembering the exact meaning of a word, sentence or paragraph from a reading passage. There was no change in literal comprehension throughout the 1970s at the national level.

High Level

- Although 17-year-olds' lower-level reading skills do not appear to be declining, the higher-level literacy skills are. Between 1971 and 1980 the average performance level for inferential reading skills dropped from 64 percent to 62 percent. Inferential comprehension requires "gleaning from a passage some idea that is not explicitly stated." Readers must use "the explicit information along with their personal experiences and thinking abilities to make predictions, form generalizations, reach conclusions, make comparisons, form judgments and create new ideas.[1]

- In a special report entitled Reading, Thinking and Writing (1981), results are presented for students' written responses to selected reading and literature items. The selections chosen allowed assessment of relatively complex interpretive and analytic skills. Students were requested to provide evaluative judgments and extended discussions of the text material. For two of the analytic tasks, the results indicate that only 5 to 10 percent of the students showed strong analytic skills. Another 35 to 50 percent showed some uneven evidence of looking at a text analytically, though they might not do so with any detail. About 10 to 15 percent showed no evidence of being able to do the analytic tasks at all (p. 16).

- To measure change in students' analytic skills since 1971, one item was administered to over 2500 students in both 1971 and 1980. Students were requested to substantiate their claims about the mood of the passage by turning back to the text for evidence. A drastic 10 percent decline was noted for 17-year-olds' ability to provide adequate analyses. In 1971, 51 percent of the students wrote adequate analyses, while in 1980, only 41 percent were able to do so (Reading, Thinking and Writing, p. 23).

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[1] Three National Assessments of Reading, 1981.

- A sample inferential comprehension exercise is shown in the Appendix. For this exercise, students were asked to identify the main purpose of an editorial entitled "Competition is Healthy," a persuasive article regarding the need for advertising professional fees and services. A successful response to this question required the reader to identify the writer's intent, which is to encourage people to see this need. The average percent correct for 17-year-olds on this item was 31 percent.

Writing

Low Level

- If lower-level skills require minimal ability to write complete sentences and paragraphs with few mechanical errors, then about 75 percent of teenagers appeared to be able to do so in 1980. From 10 to 25 percent of the students have very serious problems with written English, and this proportion has neither increased nor decreased throughout the past decade.

- Results for elementary rhetorical skills (e.g., narrative) and coherence are high. Over 90 percent of the students wrote at least marginally acceptable narratives and 86 percent of their narratives displayed coherence in 1980.

- Only 47 percent of the 17-year-olds in 1979 wrote a letter judged to be successful at straightening out a billing error. This percentage has not changed from 1974.

High Level

- Persuasive writing typically involves logic, analysis and other complex skills. In the 1974 assessment of writing, only 21 percent of the 17-year-olds were judged to be competent or better (rating of 3 or 4 on a 4-point scale) on a persuasive writing task. The 1979 writing assessment provided evidence that these skills are declining, with only 15 percent of the students receiving competent or better ratings. This is a statistically significant decline of 6 percentage points. The persuasive exercise for which these results were obtained is presented in the Appendix.

- The primary trait scoring system is used by National Assessment for essay evaluation. Rating written responses for primary traits involves examining the responses in terms of their effectiveness and whether they accomplish their intended purpose. Writing tasks are designed to measure several different types of writing including explanatory, expressive and persuasive writing abilities. The percentages judged as competent or better show a large variation across the different tasks, ranging from 15 to 75 percent. This suggests that a good many students are unable to write for different purposes and audiences. They do not possess flexible writing skills that can be varied as situations dictate.

Mathematics

Low Level

- In a 1975 report, NAEP established that well over 90 percent of the 17-year-olds could perform simple addition and 85 to 90 percent could perform simple subtraction. Between 80 percent and 90 percent could multiply and divide. Computations using decimals, fractions and integers were more difficult, but percentages were still high.

- Lower level mathematics skills are neither advancing nor losing ground.

High Level

- One of the mathematics' objectives is the assessment of mathematical understanding. Understanding implies a higher level cognitive process than recalling facts or using skills and requires translation between symbols and words (Changes in Mathematical Achievement, 1979).

The second national assessment of mathematics conducted in 1977-78 indicated a 4 percent decline in mathematical understanding. The average percent correct for these items was 62 percent in 1973 and 58 percent in 1978. Students appear to lack an understanding of the concepts underlying mathematics and have difficulty translating and interpreting mathematical knowledge.

- Mathematical application involves the use of mathematical knowledge, skills and understanding to solve problems. It requires judgment -- the ability to determine which facts, algorithms or understandings are relevant -- as well as the ability to apply the needed processes. In 1973 the average performance on mathematics applications items for 17-year-olds was only 33 percent. This percent also declined by 4 percentage points when items were reassessed in 1978, to 29 percent. Most respondents demonstrated a lack of even the most basic problem-solving skills. Students did not think through problems but rather applied a single arithmetic operation to the numbers in the problems. Clearly, problem solving is the one area that demands urgent attention.

- Multistep math problems require more than one operation for their solution. A sample multistep exercise is shown in the Appendix. For this problem, students were asked to calculate the installment payment of a loan. Although the calculations are relatively simple, four computations are required to obtain the correct response. Success on this item averaged 33 percent. This percentage is about the same as the mean percentage over 30 multistep word problems, which was 35 percent. Thus in the 1978 mathematics assessment, approximately 65 percent of the 17-year-olds did not correctly solve the multistep word problems.

Science

The 1977 national assessment of science revealed that only 46 percent of the 17-year-olds responded correctly to all science exercises. This was a two-percent decline from the average percent correct for items given in both 1977 and 1973. Additionally, for items administered in both 1973 and 1969, a three-percent decline was noted. The trend revealed by these percentages is that national science performance for 17-year-old students is steadily declining. Another way of looking at these data is that in 1977 over half of the national 17-year-old population did not respond correctly, on the average, to National Assessment science exercises. Thus, a majority of our country's 17-year-olds do not perform acceptably on exercises considered to measure scientific literacy.[2]

To examine the science exercises in terms of lower- and higher-level skills, it is useful to employ Bloom's cognitive ability classifications.[3] The four categories from lowest to highest are: knowledge, comprehension, application, and (combined) analysis, synthesis and evaluation. The results of lower- and higher-level science skills are described below.

Low Level

- A slight decline for lower-level science skills is indicated from the assessment results. The majority of biology exercises are classified in the two lowest categories, knowledge and comprehension. In 1977, the average percent correct for all biology exercises was 52 percent. Seventeen-year-olds' performance on biology items declined by one percent between the first and second science assessments. An additional one-point decline was measured between the second and third assessments.

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[2] See Science Objectives for the Third Assessment, National Assessment of Educational Progress, 1979, ISBN 0-89398-293-8, for a complete review of National Assessment objective and exercise development.

[3] Benjamin Bloom, ed., Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook 1, The Cognitive Domain, 1956.

High Level

- The physical science exercises constitute a larger number of the higher-order classifications. The 17-year-old average percent correct in 1977 was 44 percent, although it should be noted that enrollment in these courses has declined throughout the past decade. Performance in physical science declined by three percent between the first and second assessments of science. Results from the third assessment showed an additional two percent decline. The decline found for the higher-level science skills is at least twice that of the lower-level decline. Thus there are grounds for suspecting that the science results reflect the same decline in higher-level skills as shown by the other assessments.

- A sample science exercise from the analysis, synthesis and evaluation classification is shown in the Appendix. In this exercise students were asked to examine a table and select a statement supported by the data shown in the table. The average percent correct was 57 percent for 17-year-olds in the 1976-77 science assessment.

To summarize the National Assessment findings, it appears that a majority of 17-year-olds across the nation have command of very basic reading, writing, computing and thinking skills. However, although percentages may be as high as 90 percent for some basic tasks, the remaining 10 percent who are unable to perform them represents hundreds of thousands of people.

In addition to a mere mastery of the basics of today, schools must teach students the understanding and application of higher level skills, the basics of tomorrow. The data from all four learning areas -- which are developed independently -- indicate that students have acquired very few skills for examining ideas. Many are capable of preliminary interpretations, but few are taught to move on to extended comprehensive and evaluative skills. The results of these national assessments provide evidence that schools currently are not fulfilling this goal. In every learning area presented here the pattern is clear: the percentage of students achieving higher order skills is declining. Furthermore, percentages of students unable to successfully demonstrate competence range from 38 to 85 percent, depending on the type of skill.

Future Directions

As the educational system responds to these challenges there are three critical areas that must be addressed: curriculum development; personnel training and retraining; and, modification of instructional delivery systems.

During the late sixties and early seventies public education was learning how to be responsive to the academic needs of economically disadvantaged students. A major protion of this learning process was the development of curricula -- methods and materials -- that were effective in teaching basic skills to historically low performing students. The education system is now being challenged to learn how to provide all students with more sophisticated "higher order" skills. Once again curricula need to be developed. Refined methods and new materials are essential.

The most crucial area that will require a heavy time commitment is the retraining of instructional personnel. Principals, the instructional leaders of schools, and teachers must be trained to use the curriculum methods and materials that are effective in teaching "higher order" skills. But the problem doesn't really start there. There is a need to teach the teachers and leaders some of the skills that they will be asked to teach their students. This is not intended as a "put-down" of current instructional personnel; they were not originally trained to respond to the current demands. But the fact remains, many are not prepared to teach such things as: information processing skills, creativity, decision making with incomplete information, mathematical estimations, and persuasive writing.

Schools of education need to provide their students with the necessary skills. School systems need to design and implement massive retraining programs. The task is not small; the task is extremely important, for if the system fails in this task it will not respond successfully to the challenges it faces.

Another important area that will require creative policy leadership is the modification of current delivery systems. A few examples illustrate this point.

Many critics of public education like to compare the "course taking" of Americans and students in European or Japanese schools. Special attention is usually given to the sciences and mathematics. But the critics usually do not compare the length of the school day and school year when they describe the number of courses or number of hours of instruction. If the schools are to deliver comparative levels of instruction then the "time spent in instruction" must be carefully considered.

Another aspect of schooling that needs to be examined is the use of off-site computers and other technology. Creative users of home computers, computers made available through small and large businesses, communication technology locally available and other community resources need to be investigated.

The "we cannot do it because of such and such regulation" must become an unacceptable first response. And the "we have always done it this way" response must be considered grounds for dismissal or at least an official reprimand. Caution and conservation must be part of the considerations, but there is no place for inaction. Public and private education can respond to the challenges of an information society. History is full of other successful responses by the system. But success will depend upon the policy leadership provided at all levels of government. The stakes are high. We cannot affort to fail. We will be successful.

STATEMENT OF ROY H. FORBES, DIRECTOR, NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS, EDUCATION COMMISSION OF THE STATES

Mr. FORBES. Thank you, Mr. Chairman.

It is a pleasure to appear before the subcommittee once again.

This is my swan song as the director for National Assessment for Educational Progress. Dr. Beverly Anderson will become the director of the program this Friday.

I will be staying at ECS as the associate executive director for programs and will continue to provide the committee with information as you call on us.

I would ask that our prepared statement be placed in the record in its entirety.

Mr. MILLER. Without objection, so ordered.

Mr. FORBES. The shift from an industrial to an informational society has already been discussed by the other witnesses.

We are not suggesting that there are not going to be people left to perform industrial jobs and we are not suggesting that there will be people working on the farms in the agricultural area.

What we are suggesting is that the majority of people are going to be working in occupations which require the handling of information.

At ECS as we start dealing with this problem we said that the first thing we need to do is to go to the business community and say what types of skills young people are going to need to enter the labor market as they graduate from high school.

So we brought together representatives from several high technical businesses in the Colorado area and later from across the United States. We addressed that question to them.

The first hour and a half was talking about attitudes. If you send us people with the right attitudes, then that is the first thing we need, that is, the people who will show up every day and people who can get along with their fellow workers and people who will be punctual.

That, of course, is the good work ethic type attitude.

Then we moved into the basics. Congressman Miller mentioned the need for having the ability to compute and a comprehension of reading, and writing, mechanic skills, and so on.

They talk about those but they go from them rather rapidly and they move to the next level which they tag in business jargon as "learning to learn skills."

There is the ability to be able to participate in the corporate training programs and in learning new skills to be able to work their way up the ladder.

A person who gets stuck in one place and who does not have learning to learn skills soon becomes bored, dissatisfied, and they are away from the company and someone else has to be brought in.

Then the final level of skills that are the most sophisticated level of skills which is the ability to analyze and synthesize information and make decisions.

There are four levels that the business people talked with us about.

Using the national assessment data, we then asked: What can we say about where school students are today? What can 17-year-olds in the country do looking at those skills that the business people talked with us about in terms of skills?

So what we did was that first we looked at the basic skills. Over the last decade, as we have reported previously, tremendous gains have been made, especially within the historically lower performance students.

They are doing better today than they were 10 years ago. There is no question about that.

The lower 25 percent of the students in basic skills are doing better.

But when we look at what is happening to the higher performing students historically, or if we look at the student performance in the more sophisticated types of skills; that is, the ones that some refer to as the higher order of skills or the more sophisticated skills, then we have a problem.

We have a deficiency in the number of students that even have the skills. Worse, the number is going down.

For example, when we have 17-year-olds to solve mathematical word problems that contain more than one step with several complications in order to come up with the correct answer, there was only about one-third of the 17-year-olds in the country who can adequately and accurately perform those types of operations. About one-third can do it. Two-thirds cannot.

If you ask people to write persuasive statements where they have to take information and organize it and put it into a format that hopefully will persuade someone of their point of view, only 15 percent of the 17-year-olds can perform that type of task in a competent way. That is down from 21 percent at the beginning of the 1970's.

If we asked students to respond to questions where they have to infer from what they read, then there is about one-third of the students who cannot do that very well. That has dropped a couple of percentage points over the last 10 years.

That is when you are asking them, by the way, to respond to a multiple choice type test. If you ask them to respond to an item which requires them to write something, then you can subtract about another 20 percent off that figure who can adequately respond to that type of question.

So, depending upon the skill, somewhere between 35 percent and 85 percent of our current 17-year-olds do not have the skills necessary to be able to compete in the job markets of the late 1980's and the early 1990's, the technological age which they are going to be living in.

I think we have three very large problems that we face. The first is that we are going to have to develop curricula material and methods.

We had to do it as we addressed the disadvantaged students. We were responding to their needs in the early 1970's. The educational system did that successfully.

We are going to be faced with the same problem. We do not have the curriculum materials today.

A large problem is the training and retraining problem because both principals and teachers are going to have to require some new and more sophisticated skills themselves and also learn the methods of how to provide training to those students to develop in the students those skills.

Third, we are going to have to consider the modification of the delivery systems.

Several comments have been made comparing the U.S. students with people in Russia or people in Japan, depending on the amount of the subject areas which they are taking.

Something that is often overlooked is this. The average student in the United States spends 161 days a year in school.

The average student in Japan and Russia and West Germany and France spends about 240 days a year in school, and the schooldays are longer.

So, we are going to have to look at the ways that we are running our systems and we are going to have to say:

"Is the design one that fits in an agricultural society or an industrial society? Or is the design going to fit an informational society in which we live in?"

So, there is the area of curriculum, training, and retraining of educational personnel, and the modification of delivery systems to be more responsive to today's needs.

We at ECS are helping State people to develop an awareness to this problem. We are developing some programs to be able to provide them with some assistance as they look at the State level as to how they need to respond to it.

And, three, the leadership of our current chairman of the education commissioner, Governor Hunt, is working closely with our business community in saying what can the CEO's of the country and Governors and other leaders can do together to help address and solve the problem.

My friend, Ralph Tyler, reminds me continuously about the number of challenges that we face in education and that we have faced since 1917, which is where he starts.

At each one he points out how we successfully met the challenge.

I think we have another challenge and it is one that we cannot fail on. I think from what I have been hearing across the country in the last 6 months, and with the leadership from you and the leadership from the State education decisionmakers and leaders, that I am sure we will successfully meet this challenge.

Thank you.

Mr. MILLER. Thank you.

We will now hear from our last witness for today, Gary Peterson.

We are delighted you could be here today.

You may proceed.

STATEMENT OF GARY PETERSEN, CHAIRMAN, MANPOWER PROJECT, ELECTRONIC INDUSTRIES ASSOCIATION, AND VICE PRESIDENT, GTE AUTOMATIC ELECTRIC, INC.

Mr. PETERSEN. Thank you, Mr. Chairman.

Mr. Chairman and members of the subcommittee, I am Gary Petersen, vice president of GTE Automatic Electric, Inc., a major manufacturer of telecommunications equipment.

Currently I am on assignment to the Electronic Industries Association, EIA, as chairman of the association's national engineering manpower project—a project of the EIA Human Resources Council.

My testimony today is on behalf of the Electronic Industries Association. The EIA represents 380 U.S. manufacturers of electronics with estimated 1981 sales of $117 billion and employment in excess of 1½ million.

An EIA factsheet which is attached to my testimony, provides additional information.

I would ask that this be placed in the record at this point.

Mr. MILLER. Without objection, so ordered.

[Factsheet follows:]

Fact Sheet of Electronic Industries Association

1982

The Electronic Industries Association (EIA) represents 380 American companies. Most make and sell component parts, equipment, and systems for consumer, industrial, governmental uses. Others conduct research and development or provide contractual services pertaining to electronics.

EIA's membership includes companies of all sizes, ranging from very small, single-product businesses to large, multinational corporations.

The U.S. factory sales of electronic products are estimated at $117 billion in 1981. Over $23 billion of this was exported. That figure would be even higher if the electronic content in such equipment as airplanes and machine tools were to be separately identified.

Electronics manufacturing directly employs 1.6 million Americans. Of those jobs, at least 600,000 are tied to exports.

Last year, while the nation suffered a trade deficit, our industries generated a $4.5 billion trade SURPLUS.

To summarize: ELECTRONIC EQUIPMENT AND COMPONENTS

	1978	1979	1980	1981 (Estimated)	
U.S. Factory Sales	$70.5	$85.4	$104.3	$117.0	billion
Exports	13.4	16.7	20.1	23.3	billion
Imports	10.7	11.8	13.1	18.8	billion
Trade Balance	+2.7	+4.9	+6.9	+4.5	billion
Employment	1.292	1.436	1.57	1.61	million in the USA

Whether measured by production, trade or employment, the electronics sector is one of the major, positive factors in the U.S. economy.

Source: ELECTRONIC MARKET DATA BOOK 1982 published by EIA.

EIA/IBC/3-82 Revision

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Mr. **Petersen**. We are pleased to have this opportunity to testify before this subcommittee. This staement draws heavily upon the association's national engineering manpower project and a report recently distributed to EIA member companies.

Copies of the report, "Engineering: Education, Supply/Demand, Job Opportunities," are available to subcommittee members.

I would ask that a copy of this be placed in the record at this point.

Mr. **Miller**. Without objection, so ordered.

[Material retained in subcommittee files.]

Mr. **Petersen**. The national engineering manpower project was initiated in response to a continuing concern of our members about the availability of personnel with technical skills.

This concern persists despite the current business downturn that has temporarily eased technical manpower pressure. Long-term availability of trained and skilled personnel is still a critical issue.

In response to this concern, the project was developed. The project was established to identify technical manpower issues and focus attention on:

One, basic technical education in the United States and its importance to American industry;

Two, supply and demand imbalances in certain technical fields; and

Three, job opportunities in the electronic industries.

In brief, the thrust of the project is to identify and bring to public attention technical job opportunities and manpower issues and their relationship to basic education with a parallel "Call to Action."

Although the project was initiated within the electronic industries, I would like to point out that the project received support and technical guidance from the Scientific Manpower Commission, University of Chicago—Department of Mathematics—American Association for the Advancement of Science and the National Science Foundation.

Let me share with you information from the project report. This information is designed to provide the subcommittee with a general view of the relationship between technical manpower needs in the electronic industries and basic education.

A better understanding of the critical issues in technical manpower and the education system can be gained through an analysis of supply and demand for technical people.

Our work shows that although there is controversy between academicians, agencies, and professional groups concerning whether or not there is or will be supply and demand imbalances for technical personnel, there is general agreement that the supply shortages in computer science, software, and certain other engineering and science subfields will continue in the future.

This point is critical. These subfields are the vital disciplines for high technology and will be instrumental in our Nation's ability to successfully compete worldwide.

From a demand viewpoint, one study forecasts a 20-percent per year increase over the next few years for electronic engineers and technical support personnel—far more than our ability to produce them.

The same study expects demand for electrical and computer engineers in the U.S. electronic industries to exceed supply by almost 40,000 by 1985.

Quoting from our project report, one human resources executive said:

> I do not see the specialized engineering supply problem being solved in the near term. In spite of the fact that some studies show a balance in overall supply and demand by 1990, I just don't see it four a couple of reasons.
>
> First, several forecasts show the supply of engineers (as determined by degrees granted) declining as early as the mid-1980's while at the same time, technological change is occurring at a near geometric pace.
>
> Second, business has traditionally underestimated the need for manpower in times of rapid change.

Software manpower requirements need to be specifically mentioned. The demand for computer-related engineering and associated software personnel is increasing dramatically.

If there is any question of this, look at the help wanted section in any metropolitan newspaper or trade publication.

Yet, neither our national academic nor our governmental reporting agencies even include this vital, new discipline in their reports. I know of only one software degree program in the United States currently.

Technical education is the major factor in the supply of engineering and scientific manpower in the United States. Another, and probably, in my opinion, a more important one, is the attitude about math and science of both parents and students.

The pool of young people from which future engineers and scientists can be drawn is dropping—estimated at 15 percent between 1978 and 1985. Students continue to avoid math and science courses.

Among 1980 high school graduates, only one-fourth complete enough math and science in 10th to 12th grade to be eligible for entry to an engineering program. This appear to be both by choice and design.

The latter point is exemplified by a continued lowering of academic skills. The military services in an attempt to respond is considering lowering the average reading level of training manuals to the sixth grade level from the eighth grade level. I think I am the third one to mention that, so I think the subcommittee is well informed about it.

Even students who want to ake more math and science courses may be unable to do so because of a severe shortage of math and science teachers.

Qualified teachers already in our school system are leaving for nonteaching jobs. As a result, schools have turned to unqualified teachers or have dropped math and science courses.

Finally, those who track our country's overall education record conclude there has been over the past 15 years or so, a shrinking of our national commitment to excellence and international primacy in science, mathematics, and technology.

One of the best indicators is our funding for technical education at the national level. Although overall National Science Foundation funding has shown a marked upward trend recently, funding for science education has dropped significantly from 47 percent of the total NSF budget in 1959 to 7 percent in 1981, 2 percent in 1982, and a budgeted 1.4 percent in 1983.

Another factor in technical supply at the college and university level is the availability of engineering faculty. During 1980 to 1981, about 10 percent of our faculty positions were unfilled.

Computer science/engineering departments had the highest percentage of openings—those departments that produce software engineers.

These vacancies have already resulted in limiting the entry to engineering schools of that shrinking pool of qualified applicants.

Lack of state-of-the-art laboratory equipment at all education levels—especially at the secondary and community college levels—is a critical education and manpower supply issue.

Previous initiatives of this subcommittee on legislation, such as the Electronic and Computer Technician Vocational Education Incentive Grants Act, are aimed in the right direction. We commend you for these efforts.

Finally, our project points out the significant opportunities and overall job security for those with technical skills, especially for women and minorities.

Rather than comment on the specific bills before this subcommittee, we feel it might be most useful if we highlighted the educational recommendation section of our report.

Basically there are four areas—government, colleges and universities, business, and the public at large.

The recommendations for government in these areas are as follows:

First, provide additional tax incentives for donations of laboratory equipment at all levels;

Second, increase funding for science and technology education;

Third, set standards for excellence in science, math, and technology; and,

Fourth, establish software engineering—and other new disciplines—as a reporting category in national reports.

The recommendations for colleges and universities are:

One, increase salaries for faculty in shortage categories;

Two, increase educational standards and requirements;

Three, increase technological literacy of nontechnical majors;

Four, upgrade laboratories and equipment; and,

Five, inform students of opportunities in science and engineering.

The recommendations for all citizens are:

One, individual effort on the part of every citizen to work from the grassroots level to raise graduation standards and attract and retain top-quality science and math teachers;

Two, encourage programs that show children the relevance of science and math in their everyday life even though they do not intend to become scientists or engineers; and,

Three, encourage women and minorities to enroll in engineering and other technical disciplines.

The recommendations for business are:

One, establish intern programs for faculty members at all levels;

Two, work to assure retention of faculty members in colleges and universities and assist in that effort by providing part-time and/or temporary job opportunities in the private sector.

This is the recommendation that addresses Senator Hart's comment about eating our own seed corn.

Three, increase funding of engineering/scientific education at all levels; and,

Four, promote industry/university exchange programs.

We are vitally concerned about basic education in the United States because it is the underpinning of our industry's technological base and overall national security.

As one study concludes: "The declining emphasis on science and mathematics in our school systems is in marked contrast to other industrialized countries."

The quantity and quality of our education system will determine in large measure the degree to which our industry and the United States can successfully compete at the international level.

We support the general thrust of House bills 6674, 6675, 7135, 6656, and 6950, and encourage subcommittee members to consider the recommendations in our project report in making specific modifications to these bills.

Thank you for the opportunity to address this subcommittee. Copies of this statement, as well as the association's project are available.

Mr. MILLER. Thank you very much.

After listening to all of you, it seems to me that we appear to have somewhat of a bifurcated problem. We have an immediate and short-term problem in terms of whether or not we have personnel at the college level to teach the kind of skills that are necessary for people to take their place when they have job openings and to pursue their mathematical and scientific education.

My concern is this. I said this earlier. If I am all wet, then tell me so.

But it seems to me that there is a much more fundamental problem which is the preparation that a young student receives in terms of the most fundamental ability to read and to compute, which causes the student to opt out of this system long before he ever considers an occupation.

It seems to me—and I do not want Government by anecdote—but with my two sons their choice constantly is to try to remove themselves from the mathematical field.

Fortunately they have stayed there and they have done rather well, but it is something that we pass on to our children, which is this avoidance of technical areas.

We were always told at the third grade level that math is hard and difficult. But nevertheless it seems to me that these students collectively made the decision to opt out long before they were told that there were great job openings or that there would be a need for this kind of a skill.

In terms of the pool of people who could exercise the option, and even if you could convince them, it seems to me that they have taken themselves out of the running.

Either they are not sure of their own ability or they have sought to avoid the field.

To me, that may be a more serious problem than whether or not there are faculty vacancies currently on the college campuses.

What about that?

Dr. SELBY. I could not support your statement more. I think this is an example of where we say it is a comprehensive problem because there has been very exciting recent work of the tremendously deep interrelationship between reading and mathematics and the learning stages at the very earliest levels.

So, I find it difficult to talk about any specific literacy without including the total math reading awareness of the world and the kinds of skills that Dr. Forbes was talking about.

In our Commission's statement on the problem, you will find that we are talking, as I already mentioned, about the fact that schools create communities as much as communities create schools and vice versa.

It is the attitude toward science and math by teachers that kills the motivation. I can say this because it existed in the school that I was responsible for. It is an attitudinal problem that I feel most people do not know about.

I would like to relate to the other point about what is the difference between this and post-Sputnik. Post-Sputnik gave us the concern for the most highly trained scientists, mathematicians, and so on.

Today, our Commission is saying that the focus must be on everyone. The highly trained broaden the pool, but until we get a society where that first grade teacher was herself turned onto science in the first through eighth grades, then we are not going to get the kind of teachers that can really help open the windows.

As a scientist, I see science as one additional way of looking at the world. Too many people are still talking about a dichotomy between two cultures.

We have not found the words yet. I will reach for the ways to try to express science not as another part or as a different part of learning, but integrated into all learning.

There are long-term solutions but meanwhile we need so much of what has been discussed today. But if we can just start to look to all of learning as integrated and science and math as part of it, then the best reading programs that I know are reading programs that turn the kids on to reading because they get so excited about what they are reading.

If they are reading about Star Wars and Pac Man, then that is fine. There are ways to get that reading related to very important early number theories.

So I think the pieces are there but we need leadership to put it all together.

Mr. MILLER. Mr. Petersen?

Mr. PETERSEN. I think a very interesting thing came out of our study.

We started as a somewhat limited industrial study in supply and demand. When we got into the project very far we saw that you really cannot talk about technical manpower in the United States without talking about basic education.

Over a period of time I think the thing that has come through to me and one of the reasons we are taking the approach that we are taking is that the basic public in the United States is not aware of what I consider to be an almost near crisis in basic education in the United States.

This basically takes us from a business standpoint, if you take 20 to 22 years to turn out a product. You do not get the youngster at the engineering level until he is 22 years old.

In talking with people about education and about their occupations and how they are encouraging their children, the average person takes a look at the tax bill and sees that education is the largest incremental item in that tax bill.

This is an individual judgment, but my judgment is that they tend to dismiss education by saying that if they are spending that kind of money on it, then they must be doing a good job.

That in itself is a fallacy in the relationship between money and what is happening.

Second, I really do not think that people are aware that our youngsters are having as much difficulty as they are in higher education or in occupations.

Third, the average person really is uninformed about the preparation at the elementary and secondary level to be building blocks to careers in the future.

I think that one of the things that the subcommittee is doing—and it may be far greater than what you are doing at the specific bill level—is that if we can articulate at a mass level what some of the basic problems in education are, then we have a gone a long way down the road.

I know in our particular project, the second level of work that we are doing is to try to get a mass distribution and get a lot of work at the grassroots level to try to get the average American involved in his school system and to try to encourage the kind of private-public initiatives that we have heard about this morning.

I guess, in our judgment, that probably is one of the most significant things that we possibly can do which is to bring to the attention of the American public that there is this crisis in education and what they probably can do about it.

One of the things is that our youngsters right now, from a business standpoint, if we want to be competitive—and human resources is a factor in that competitiveness—that our youngsters just are going to have to work as hard as or greater than their international competition.

That is what we have heard this morning. They are working harder and they are putting in more time than we are in terms of our foreign competitors.

Mr. MILLER. Governor Evans?

Mr. EVANS. Your comments are related to the elementary schools. One of our difficulties is that youngsters know a lot more than we think they know and they are a lot more capable than we think they are.

Inherently they are learning a good many things, unfortunately, which are in an organized educational system. They are learning a great many things from television and instead of wringing our hands over the amount of time that youngsters spend in front of the television set, we ought to figure out ways to make that a more meaningful and good experience.

We see community after community now attempting to deny to their youngsters the opportunity to play Pac Man or any one of the many, many computer games which are out.

Yet, inherently those students are learning a good deal of mathematics, but it is never translated to them in that respect.

I would dare anyone in this room to challenge an average 8-year-old to any of those games. They will beat you. They inherently understand lead times and probabilities and a whole lot of mathematical elements. But nobody has ever taught them those elements.

I think that instead of worrying about their abilities to learn or even worrying about what they know inherently, we have to somehow connect their experiences and what they are spending time on and change some of our educational methods.

We still are teaching the elementary grades with the multiplication tables instead of probabilities and associating the kinds of basic mathematics with the things that youngsters are most familiar with and find easy and find to deal with. That is the computers and the various kinds of modern educational equipment, which is not being used to its fullest extent.

The most popular single course that we have at our college is taught by a computer. It is a course on how to program in basic computer language. It is a self-taught course. It takes about 30 hours, but it is on your own time. You interact with the computer and it turns out some very, very fine results.

It is now part of the National Control Data Plato System Course.

So, we have to use some of our modern methods that not very many teachers yet are capable of utilizing, and in doing so, I think we can reencourage our young students at a very early age into mathematical and scientific pursuits.

Mr. **Miller**. I am not terribly concerned whether we go into mathematics or science.

Mr. **Evans**. I am talking about literacy.

Mr. **Miller**. My concern is the question of basic literacy. The youngster needs to be able to exercise options when they are presented. He should be able to say yes or no rather than "I cannot," which is a far different determination.

But if that is the nature of the problem—and I suspect to a great degree it is—then we are rather limited at this level.

We have done some things that had great success. Unfortunately, they are not immediately popular, but the title I program was for the bottom 25 percent. They do, in fact, compute better and read better.

There is a limit. The more I look at the elementary system, by its local nature, it is like Gulliver being tied down on the beach. There is very little at the Federal level that we can do to change this attitude and to change the fundamental perception as to what the local education system should deliver to its constituents.

I am talking about quality education. We provide incentives and we provide restrictions, but I am not sure that we really have much impact on the attitudes as to whether people who view their teachers as professionals and should be rewarded as such or whether or not the school system meets the demands that those families have.

So, I am concerned that we concentrate here at the Federal level by picking out the immediate rewards off the tree here in the political sense and fail to understand the very fundamental nature and the magnitude of the investment that must be continued.

It cannot be popular and unpopular. It has to run through at least 10 years or something so there can be a full benefit.

This is almost an avoidance process on our part to say: "Well, if we put computers in the schools or provide a vocational education program * * *."

Then if the kid arrives at that point and cannot read or think in a logical fashion, then we start all over again. We start with remedial programs.

It is a process that becomes more and more expensive in that effort.

I think the young person today would logically give strong consideration to a technical profession because of the marketplace and the opportunity, perhaps over being a lawyer at the moment.

But he might be precluded from doing that.

That is my concern. I think the marketplace will decide where people will go. But I am concerned that those decisions are somehow made for them long before they can read the want ads, so to speak.

Mr. Erdahl?

Mr. **Erdahl**. Thank you very much, Mr. Chairman.

Let me touch on three questions for any member of the panel. I want to thank the panel for being here.

Let me address this to Dr. Selby. In this country, I think we have had a traditional historic stereotype that girls do not do as well in science and math as the boys do.

It seems as though we have somehow permitted this to exist, and in so doing, are wasting a tremendous reservoir of talent and ability.

Can you comment on this? Is this no longer the case? Am I mistaken?

Dr. **Selby**. This comes back to what Congressman Miller was talking about, which is the attitudinal development.

I can give you case studies from my experience in North Carolina that show this.

We had about 75 girls in our 1st to 11th grade at our School of Mathematics. About 2 or 3 months after they arrived at the school, there was a statewide mathematics test.

Lo and behold, two of our girls placed higher than anyone in the school and were the first two girls to place within the top 10 of the State.

The point was that we had not taught them the mathematics. They had only just arrived with us. But what they got from us was an environment that encouraged them to go for the test.

As soon as they had an appropriate attitude, they achieved.

In my experience, you could extrapolate that story. I will bet you anything that this year there are many more girls placing in the top 10 in North Carolina simply because there was the example and the encouragement there. There was the possibility of an attitudinal change.

I will not bore you with more cases, but there is no question in the stereotyping you mentioned.

There is also the socioeconomic differences, whether minority or tobacco farm kids in North Carolina. They have not been conditioned to believe that they can do physics. It took us a lot of effort and a lot of environmental tender loving care to get them around the idea that physics is kind of beautiful.

They then took it and said: "My goodness, it is not difficult; it is beautiful."

But it takes an environment to create that atmosphere. As an educator, the most common cause of not trying in kids, whether it is kindergarten or 12th grade, is fear of failure. We have given a lot of fear of failure to our students, particularly the less privileged.

This is part of the total kind of environment that we must turn around.

If you will forgive me, adults have fear of failure with respect to science also. We have heard some comments this morning about not understanding this and not understanding that.

We give a lot of messages when we say things like that. As adults we have to watch what we are saying to our kids, and if you will forgive me, perhaps constituencies, too.

Leadership, in terms of your problem, Congressman Miller, to even say in your community that this is important will start turning some things around.

Youth listen, but I notice there are a lot of businesses now where adult executives are taking internal training programs to try to understand science and technology better.

I know of some corporations in New York that are doing this. That is an example. That will say something to kids. You will find that if you are humble enough to do it, it will be part of an attitudinal change on the part of the young people.

Mr. **Erdahl**. Hopefully you and others like you will continue to challenge the young people. I think they will rise to the level of our expectancy. We should not forget that.

This was brought to our attention by my colleague from Pennsylvania, Congressman Goodling. He talked about the concept of lend-lease. We could see this exchange between the private sector and the business community and the educational institutions.

Maybe in the short term we could deal with some problems. Maybe we should try to expand that without threatening our own institutions in this country to foreign countries.

If we could have a lend-lease arrangement with competent teachers in the society from other countries, then maybe someone would be disturbed to have some Russian mathematician teacher in the schools here, but I think our kids might learn some math and physics from him.

If he did not learn democracy, he certainly would learn some independence from our kids. Maybe that would be a good thing to do.

Ms. **Selby**. My caveat is this. I mentioned partnerships. What I would beg for is that we understand the teacher, no matter what the subject matter specialist that teacher has built up, the teacher is the specialist in children and in youth.

The teacher is the specialist in knowing stages of development and in stages of learning. The subject matter context expert, like the Russian mathematician, can work in partnership with the teacher, provided there is a partnership so the subject matter person is related to the person centered teacher.

I think in that way we could build up the studies of the teaching profession as the people who know kids and learning.

Then we perhaps can partner with them specialists with their own piece of the action.

Mr. **Erdahl**. Mr. Chairman, I have one other question. I would direct this to Mr. McGuire.

Is not the lack of competent teachers in the science and math area—and I guess we would all acknowledge this, in effect, is the case—but is not this lack, to some extent at least, an indictment of our educational system and maybe even of the teaching profession itself?

Mr. **McGuire**. Are you referring to the shortage?

Mr. **Erdahl**. Not only the shortage, but also maybe the competence. I am from Minnesota. I think we have a good system there.

But we have heard about teachers being pressed into service in areas who are shortly outdistanced by their bright students.

Mr. **McGuire**. Teachers who can cite students and carry them beyond their own levels are very important, and always have been.

I think that we have to look at education in the broad spectrum. I would like to tie my answer to this with my thoughts to some earlier conversation today.

There is the need to have a partnership with all facets of society in order to solve the problems. For the teaching profession to seek to solve it alone will not work and for other singular segments to try to solve it alone will not work either.

I think tying it to my testimony under the ADEA, there is a uniqueness and ingenuous in this in that it brings about the partnership in planning in order to achieve the incentive grants.

Those tied together very nicely in 1982 when there is a shortage of funds that there is an incentive in order to have funds to do something about it.

Taking Mr. Petersen's testimony about the fact that the persons are not aware of what is going on in the schools, there are fewer households in America with a direct tie with schools than we have ever had before. It is down into the 20-percent category.

Certainly as business sees the need and as the professions sees the need, and as labor and the community at large see the need, and as they work together to see what they can do about these difficulties we have talked about this morning, then it will include the whole spectrum of the matter of writing and reading and of the fear of science and mathematic courses.

I can heartily agree this is passed on by things adults say in the home and what they say in the community. It is also passed on by the strong competition for grades. Persons who would rather carry a high point grade average out of a high school situation rather than be challenged is influenced by the situation.

But the teaching profession stands ready to work with the community and to work with business and to work with labor and to work with some dollars.

Many of the things that were spoken of today are direct results of cuts in commitment at the local, State, and Federal level toward education.

So, the National Science Foundation, for example, did not reach a conclusion that a smaller Federal commitment would help them achieve greater things.

This was thrust upon them.

You have the local taxes. You want to see how much they are, as was stressed by my colleagues on this panel. This was a matter that the local taxes are visible.

It is a tax where the mail comes to the house and they see what their property tax is. Then it is quite different from the State withholding tax or the sales tax at the grocery store or other stores or the Federal income tax.

So, I think it is an indictment on society as a whole, to get back to your basic question.

We have let education move its own way without concern as to the funding of it and the need for it to be a high priority.

Anything that will get all of our society together, discussing these needs and making a local plan for upgrading teacher qualifications and a plan in terms of what the curriculum should be in that community and what the stresses should be certainly will be an improvement from just letting things go.

Thank you.

Mr. ERDAHL. Thank you very much.

I thank the Chairman.

Mr. MILLER. Governor Evans, let me follow up on a point you made about the use of technology and young people's attraction to it in other forms than what we consider pure education.

I would assume that you and other members of the panel would agree that this technology should be used in other fields of endeavor.

We saw examples at the San Francisco hearings, where Mr. Peterson testified, of geography being taught with software. There was a whole line of other skills so that we were not just using technology to teach traditionally technical subjects.

You would encourage that efforts in terms of familiarity and use of those skills; right?

Mr. EVANS. I certainly would. As I said, we deplore the fact that students spend so much time in front of the television set. Why do we not use that CRT tube in a more organized fashion and use that enthusiasm for that method of transmitting knowledge in a way that will aid us in our task?

I just think that in a case where knowledge is expanding as rapidly as it is, we may really be finding that reading, as we have traditionally known it, is simply too slow of a way to transmit knowledge.

You might have to add to the reading the visual stimulus and the uses of all senses in a way for students to learn faster.

There is a lot more to learn and in many respects we are trying to teach it the same old way. I do not think that is adequate.

Mr. MILLER. One of the things that concerns me about this discussion is the idea that we are talking about the creation of a

Brahman class within the educational system that only science and mathematics teachers are worthwhile.

It seems to me that we also have to relay to school districts and to educational establishments that teachers have a role to play and a very important role in this effort. The reading teacher is as fundamental to the core of this effort to increase participation by students in science and mathematics as the mathematics teacher or the science teacher.

I would hope that if that is accurate—and at least it is my view—then I think we will be on the right track. A lot of teachers think they are doing a good job in turning out students who read. It looks that way until they take the test. Then it turns out to be the science and mathematics teachers who turn out being the ones doing the most good.

But we may also mislead parents as to what students need to know. If they can simply work the keyboard and compute then reading is, in fact, not necessary; there are a lot of signals that we had better be clear on in this accelerated effort that I suspect is going to come in spite of my reservations about this issue of science and mathematics.

Mr. Evans. Computers are lousy poets. That is important to know. We need to accommodate the new techniques, but at the same time do not forget that some of the other fundamentals create a unified worthwhile society.

Mr. Forbes. Maybe what is going to happen is that we are going to need two levels of basic skills. There will be a group of jobs in which today's basics will be satisfactory for.

But then there will be a whole other group of jobs where every student will have to be retrained and will be given the opportunity to move into those better paying jobs and the more exciting jobs. There will be a new set of basic skills.

There will be things like being able to analyze, read critically, infer from what you read, synthesize, estimate, problem solving, making decisions with incomplete information. And all of those things cut across a number of areas other than just mathematics and science, although mathematics and science are a very large portion of it.

But the writing and the English and the literature aspects and the music and arts aspects are a part of it.

If your concern is that we are too narrowly focused on math and science, then I would share your concern.

I think what we have to do is to say: What is that new set of basic skills that is going to be required for people to compete in the job market in 1990 or even 1987 or 1985? What is that new set of skills? How can we, as the educational system, working with the business community and working with the political leadership, make sure that we are providing the opportunity for students to learn those particular skills?

To me it is a shift in what we call basics today. In some way we have to get that across to the public because just to train students in today's basics is going to be locking a number of students into very limited job opportunities in the future.

Mr. Miller. I agree with what you say. I still believe that education is the sum of our experiences.

But there is an effort now in a technical sense to try to bobtail a good education onto a defense rationale or a technical rationale instead of standing up and saying that children need to read, write, compute, and think.

If we are going to spend dollars, then it is thought that we have to talk about somebody unable to drive the M-1 tank. I am not terribly concerned about that.

I suspect once again that if the student is well educated, then he can learn to drive the M-1 tank or any of the other efforts necessary.

But there is a shyness, certainly within the political community, to suggest that we are still talking about whether or not we can present the young people in this country with a fundamental, well-rounded education and what the cost of that endeavor is.

We could export all of our students to Russia, if you listened to enough comments this morning, and let it be done there because apparently it is being done so much better there.

There is little to show for that effort. I think the editor of Scientific America was writing that they have 9 years of physics.

I appreciate that, but I also appreciate the fact that they are going to great lengths to get American technology and are having great difficulty moving natural gas from one part of the country to the other.

It does not mean that we can sit back, but it seems to me that we are very quick to indict a lot of people. We rarely have the evidence to do it, but we do it.

But the system has a lot of successes written into it.

I am just concerned that we not run off half cocked with a political Chicken Little that somehow the house of cards is entirely falling on us with respect to our ability to compete in the scientific and technical fashion.

I think like any other system the educational system, after 200 years, needs some remodeling and needs some new supports and some reinvestment and the general maintenance that a lot of systems in this country need.

Perhaps the very fundamental participation in terms of the support of the parents is important. Mr. Peterson pointed out in our San Francisco hearing that the basic fiber of the system is as much in question as its ability to deal with the specifics later on in that system.

That is my view.

I want to thank you all for your time. We appreciate your presence here.

Dr. Selby, when is the next meeting of your commission?

Dr. SELBY. October 19, here in Washington.

Mr. MILLER. What is the subject matter?

Dr. SELBY. It is an open meeting. It will be held at the National Science Board Room in the NSF building. There will be reports from each of the task groups reporting on the professional societies and the individuals and the media, reporting on various hearings as well as assimilation of various research studies.

So, each of the task groups will report thoroughly.

Governor Evans is chairman of the task group on governments.

Mr. **Miller**. And the December meeting will be for what purpose?

Dr. **Selby**. We will probably work on the agenda today for that meeting.

My hunch is that we will plan the December meeting as to what we have not yet touched on as is revealed in the review as to what the task forces have done.

I am sure there will be gaps found. We will try to fill in those gaps between October and December. Then in January we certainly will be into the phase of recommendations.

This is the best that we have seen. What does that tell us about what we want? Do we have some other ideas as to what will help?

Mr. **Miller**. I thank you all again.

The hearings will continue tomorrow on this subject.

We will now adjourn.

[Whereupon, at 12:20 p.m., the subcommittee was adjourned.]

[Additional material submitted for inclusion in the record follows:]

STATE OF PRECOLLEGE EDUCATION IN MATHEMATICS AND SCIENCE*

Paul DeHart Hurd (Emeritus)
Stanford University

In recent months the scientific and engineering communities have been exploring ways to maintain the vigor of research and technological innovation in the United States. In the course of these discussions several disturbing problems have emerged relative to the teaching of precollege science and mathematics. For nearly a decade science enrollments in high schools have been decreasing and students are demotivated to study science. In mathematics students are taking more semesters of courses, but show an overall decline in achievement. For both science and mathematics courses there is a growing shortage of qualified teachers. If a reasonable degree of scientific and technological literacy is an expected outcome of a high school education, it is not being achieved (1).

This report identifies an agenda of issues as a background for considering science and mathematics education in precollege schooling. My comments on trends and issues are based on the best available data, which at times are incomplete and may be contradictory. There are 16,000 independent school districts in the United States, each with science and mathematics programs of their own design or selection. Any statement that can be made about teaching or teachers can most likely be contradicted with information based on local or regional conditions. The issues identified in this report are products of a conceptual analysis and synthesis of a variety of reports, surveys, and other documents issued by scientific and professional societies within the past decade. By and large, only those issues that are of national concern and have a modest consensus are being reported.

The Quantity of Science and Mathematics in the Education of Precollege Students

Children are introduced to science and arithmetic in grades one through six. Teachers state that they devote an average of 44 minutes per day to mathematics and 20 minutes to science (2). In a week's time of 25 instructional hours children will have had one hour of science and somewhat less than four hours of arithmetic.

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*Prepared for the National Convocation on Precollege Education in Mathematics and Science, May 12-13, 1982, National Academy of Sciences and National Academy of Engineering, Washington, D.C.

At the junior high school level (grades 7,8,9) general mathematics and general science are taken by nearly all students. About two-thirds of the students in the ninth grade will enroll in an algebra course and a specialized science such as earth, physical, or life. The remaining third of the students will continue in the general course (3).

In the spring of 1980 information was obtained from a highly stratified national probability sample of 1,100 high schools and 28,000 senior graduates representing 3,000,000 seniors in 21,000 high schools (4). The findings show (cumulative) that 93 percent of the seniors completed one or more years of mathematics, 67 percent two years or more, and 34 percent three years. Thus, in 1980, out of a total of 3,000,000 graduates from high school a total of one million had credit for three years of mathematics. The distribution of these mathematics courses was algebra I, 79 percent; algebra II, 49 percent; geometry 56 percent; trigonometry 26 percent; and calculus 8 percent (5). The survey revealed that only 54 percent of high schools teach trigonometry and 31 percent calculus.

If students are classified according to the type of curriculum pursued--academic, general, or vocational--98 percent of the students in the academic category had one or more years of mathematics, 86 percent had two or more, and 55 percent three or more. Only a fifth of the general and vocational students graduate with three years of mathematics. Twice as many seniors (48 percent) living in the northeastern states take three years of mathematics compared with seniors attending western schools (24 percent) (6).

The distribution of students in each of the three types of high school programs at the time of graduation was: academic 39 percent; general 37 percent; and vocational 23 percent. Since 1972 there has been a 4 percent decrease in the academic programs and a corresponding increase in the general. The vocational enrollment has remained constant (7).

The years of science taken by students graduating from an academic program were: one or more 96 percent, two or more 44 percent and three or more 41 percent. Only 13 percent of the general students and 9 percent of the vocational students will have taken three years of high school science by graduation (10). (See also 8 and 9.) More than twice as many graduates (35 percent) in the northeast states have a record of three years of science compared with graduates in the western states (15 percent) (11). Three years of science can be satisfied in many ways in secondary schools. Most students begin with a course in biology, followed by chemistry for 37 percent and physics for 19 percent. Other students complete their three years of science with a selecton from biology II, earth science, physiology, space science, aeronautics, oceanography, physical science, geology, ecology, environmental science or from a host of one-semester courses. The pattern of courses taken is greatly influenced by college or university admission requirements.

There are racial/ethnic and sex differences in the mathematics and science course work of high school students. Asian Americans take more science and mathematics than either whites (second) or blacks (third)

(12). Males take more science and mathematics than girls except for algebra I. The proportion of males in vocational programs has increased since 1972 and the proportion of females decreased.

Enrollments in school subjects are influenced by student attitudes and school requirements. Students do not particularly like science courses and this dislike is acquired early. By the end of the third grade, nearly half of the students feel they would not like to take science (13). Only 21 percent of eighth grade students have a positive attitude toward science courses and this percentage remains constant through high school. The main reason for not liking science is that there are too many terms to memorize (14). The popularity of mathematics drops from a high of 48 percent in grade 3 to a low of 18 percent in grade 12 (15). The most frequent question raised by students in mathematics classes is: "How am I going to use this stuff?" The usual answer: "You will need i. to pass the next course." The encouraging note is that students like science when they learn about it outside of school on television, at museums, planetarium, or "marine worlds."

The Quality of Science and Mathematics Learning

Since 1960 the average achievement scores in science and mathematics on a variety of test instruments have shown a steady decline (16, 17). Scores on the Scholastic Aptitude Test (SAT), widely used by colleges and universities for making admissions decisions, provide evidence of the decline in mathematics. The mean score in mathematics has dropped from 502 in 1963 to 466 in 1980. The proportion of students scoring above 700 (possible 800) on the SAT mathematics test declined 15 percent over an eight-year period, 1967-1975. During the same interval students scoring below 300 on the mathematics section increased 38 percent. Data from the American College Testing Programs for the years 1965-1966 and 1973-1974 show that mean scores on the natural science test remained stable.

In 1969 the Education Commission of the States began a nationwide program to assess the educational attainment of young Americans in certain subject areas. The program, known as the National Assessment of Educational Progress (NAEP), gathers census-like data to measure growth or decline in knowledge, skills, understanding, and attitudes of precollege students. Science measures were made in 1969-1970, 1972-1973, and 1976-1977 on age samples of 9-, 13-, and 17-year-olds. The mean score of correct responses in science has declined with each assessment, the greatest decline occurring in the 1970-1973 period. The decline between 1969 and 1977 is least for 9-year-olds and greatest for 17-year-olds. Each successive test shows a greater decline in scores on physical science topics than for biology where there was a slight increase in knowledge for 9- and 13-year-olds (18).

There have been two national assessments of mathematics, 1972-1973 and 1977-1978. "In overall performance, 9-year-olds showed a negligible decline, 13-year-olds a 2 percent decrement, and 17-year-olds a 4 percent decrement" (19). The tests included measures of mathematical understanding, skills, and the ability to make applications. Overall the last decline in mathematical ability was found among 9-year-olds, their poorest showing was in their ability to apply what they had learned (20).

A study of achievement scores on NAEP tests for black and white youths indicates that during the 1970s the difference between races in science and mathematics has decreased. "Typically, when achievement for white students has declined, that for black students has declined less; when whites have improved blacks have improved more" (21). The greatest difference in science and mathematics achievement between races is found at age 17.

The achievements of females in mathematical abilities are comparable to or superior to those of males in some areas, at age 13. But by the 12th grade males surpass females in most areas of mathematics. Fewer women, 37 percent, take four years of mathematics than men, 41 percent. "When 12th grade men and women who have taken the same mathematics courses are compared, results show little difference in their achievement in computation and algebra. But, with the exception of those in precalculus or calculus courses, high school senior men have an advantage of 6 to 12 percentage points over senior women in tasks involving word problems" (22).

The College Entrance Examination Board develops advanced placement tests in science and mathematics and has done so since 1955. Students who elect to take these tests usually expect to major in a science or a mathematics field in college. To prepare for these tests many high schools offer advanced placement courses. In the sciences this is usually a second year of chemistry, physics, or biology. A college level introductory textbook often serves as the curriculum. In mathematics a course in calculus is essential for meeting the advanced placement requirement. In the decade 1969-1979 the number of students taking advanced placement examinations increased from 24,300 to 49,600. The mean reported grades in science and mathematics have increased every year from 1969 to 1979 (23). The top students in science and mathematics appear to be getting better.

The results of various testing programs indicate there has been a modest overall decline in science and mathematics achievement since 1970. However, the "top" or "brightest" high school students do about as well on academic achievement measures now as they ever have. If we can assume that high school graduates who score well on advanced placement examinations in science and mathematics are the best qualified for pursuing scientific and technical careers, our schools are generating a talent pool of 50,000 students each year. The number of high school graduates was 3,160,000 in 1979. Although 55 percent of the graduating seniors from academic programs in the secondary schools have taken three or more years of mathematics, enrollments in remedial mathematics courses in public four-year colleges have increased over 70 percent in the past five years. America appears to be losing ground in qualifying students for middle-level careers in science and engineering. A majority of high school graduates will become members of the fastest growing minority group in the U.S., the scientific and technological illiterate.

It should be noted that tests of achievement are developed to measure what is being taught as represented by courses of study and textbooks. Test makers do not attempt to improve or guide curriculum development by including questions on what ought to be taught.

America in Transition

The ills of schools broadly reflect those of society as well as shifts in the culture. About half of the decline in school achievement across academic subjects since 1970 appears to be due to social and cultural factors (24). In the late 1960s, scholars in the social sciences reporting on changes in America described conditions as a "cultural mutation," "a watershed period," the approach of a "post-industrial society," the "emergence of a new technological age" and the rise of "a learning society." It was about this time when a few economists began to regard the utilization of knowledge, especially scientific and technological, as a productive factor rather than a consumer item (25, 26). The study of knowledge production, diffusion, and utilization is in itself an emerging discipline along with information processing. An increasing percent of the work force is connected to the retrieval, processing, and transmission of information. The role of microelectronics for enhancing the intellectual capacity of the human mind may well add a new "basic" to education. Notions about the aims, substance, and quality of education in the United States must certainly respect the changes taking place throughout all of life. Some teachers think students have already noted the gap between schooling and the real world and are taking a rest until educational conditions improve.

When parents feel there is something amiss with schooling they protest with a cry of "back to basics," "no frills," or "teach fundamentals." Parents generally define "basics" to include respect for authority, good manners, less permissiveness in schools, home assignments and classroom discipline. "Back to basics" is not a true educational issue; no one questions the value of reading, arithmetic, and writing. A more serious question to many educators is the overemphasis on reading and arithmetic in the elementary school and the neglect of science, art, music, and the social studies. Reasoning, responsibility, and reverence for democratic values are also "Rs" widely neglected (27). The central issue is that students enter high school deficient in reading, writing, and mathematical skills, as well as in knowledge about science, civil rights, politics, music, and literature (28). The decline in academic achievement is across all subjects. The problem is to restucture the educational system to provide checkpoints at several grade levels to ascertain learning deficiencies and then to establish correctives.

There are a number of factors that appear to have a negative effect on the achievement of the highest possible quality in American education. No one of these conditions stands alone but each plays a part.

- Students with high achievement test scores spend more time on homework than students with lower scores. Female students and Asian Americans spend more time on homework and receive higher grades than males and other racial/ethnic groups (29). In general, students who report doing the most homework and the least television-watching scored higher on the national assessment in mathematics (30).

- Children having parents with some college education and living in the suburbs showed little decline on measures of educational achievement over the past decade.

- Based on the results of NAEP measures it appears that after age 13 future achievement in the sciences is influenced as much by socioeconomic and cultural factors as by schooling.

- Changes in living styles and family structure for close to half the families in the United States result in an unfavorable study environment in the home.

- Sex stereotyping in regard to science and mathematics achievement expectations is evident by the time students enter the sixth grade.

- A mix of factors shown to influence the quality of American education are: automatic grade promotion, inflated grades, absenteeism, lowering of college entrance requirements, breakdown in class discipline, unfavorable study environment at home, lack of homework, loss of public confidence and support for schools, unclear educational goals and policies, reliance on remedial courses in high school rather than corrective courses in the elementary school, forced "streamlining" of students, and teacher disillusionment.

- The typical school year in the United States is 180 days, the average number of days of school attendance is 161 (31). Time-on-task is a significant factor in educational achievement.

- Students are not unhappy with their schools. Three-fourths of those in academic programs rate the reputation of their school and the quality of instruction as good or excellent. Students in general and in vocational programs are less satisfied (50-60 percent) with the education they are getting. Looking back, 70 percent of all seniors feel that schools should have placed more emphasis on vocational and technical programs, and 67 percent wish that more emphasis had been given to basic academic courses (32).

To revitalize the quality of school science and mathematics education in the United States will require a consideration of social and cultural conditions impacting schools, as well as the revitalization of curricula and instructional practices.

Some Constraints Influencing Science and Mathematics Education (33)

The United States lacks national goals, public policies, or an agenda to focus discussion and debate in the reconstruction of science and mathematics education. As a basis for policy, the need for a high level of scientific, technological, and computer literacy for all citizens is most often identified. If this is to be a goal of science and mathematics education at the precollege level, parents, teachers, and school administrators must first recognize its significance.

The School Curriculum

Doubts exist as to whether the commonly offered science and mathematics courses in high school are of value to the general citizen, at least in their present form. Students regard upper level mathematics, physics, and chemistry courses preprofessional subjects for those who wish to become engineers, mathematicians, or scientists (34). For science subjects the issue is: What knowledge acquired in the past 100 years from various science disciplines should be selected to provide 160-clock hours of instruction for a high school course? Not only should this knowledge be scientifically valid, but it should also satisfy the requirements of cultural validity.

Throughout the past decade half the colleges and universities in the United States have developed courses or programs designed to interrelate science, technology, and cultural imperatives (35). Courses are offered with such titles as "science-technology-society," "science-technology-values," "human biology," "human ecology," "science and ethics" and other names representing themes on science and the culture (36). At no other time in modern history can one find a science curriculum adjustment in colleges and universities of this extent. These are all courses designed to make it possible for citizens to participate more wisely in the affairs of a science/technology based society (37). However, one seldom finds a high school science or mathematics course taught in the context and with the aim of effective citizenship.

Supply and Qualifications of Teachers

The shortage of qualified mathematics and science teachers for American schools has become a matter of serious concern. A survey including 44 states in 1980 revealed that 28 states had a shortage in mathematics, and in 16 states the situation was listed as critical (38, 39). For 1981-82, 27 states report a critical shortage of physics teachers and 15 more states report a shortage (40). A shortage of chemistry teachers exists in 38 states (40). General science teachers are in equally short supply. For the ten-year period 1971-1980, a survey of 600 colleges and universities with teacher training programs revealed: 1) a 77 percent decline in the number of secondary school mathematics teachers being trained and a 65 percent decline in science teachers; 2) of those trained to teach science or mathematics, a decreasing number go into teaching, choosing business or industry instead (40). Nationwide, of the teachers employed by high schools to teach mathematics or a science for 1981-82, 50 percent were unqualified and were teaching with emergency certificates. In the Pacific states, 84 percent of the mathematics and science teachers hired for 1981-82 were unqualified. In 1980-81 almost five times more science and mathematics teachers left teaching for employment in nonteaching jobs than for retirement (40).

Over the last two decades teacher training institutions, normal schools, and teachers' colleges have disappeared from the American higher education scene. The academic preparation of mathematics and science teachers has become an unrecognized responsibility of these departments in colleges and universities. These departments typically do not offer or require the range of background courses needed by teachers to qualify them for teaching nonspecialists. Some of these courses, for example, might be the sociology of modern science, statistical procedures in the behavioral sciences, human ecology, technology achievements, decision making embodying concepts of risk and probability, and general courses which provide a perspective of an entire discipline. In terms of professional qualifications science teaching and engineering occupy the same position relative to science. Both are applied fields. Engineers select information from the sciences and mathematics to solve problems. Teachers select information from these same fields to interpret science to nonspecialists. However, the education of a science teacher, an interpreter of science, is that of a researcher cut short at the end of four years. No other industrialized country has defaulted on the education of science and mathematics teachers to the extent the United States has. The biology education committee of the National Academy of Sciences expressed concern about this situation in its 1970 report (41). Not only is there a shortage of qualified science and mathematics teachers, there is also a shortage of college programs to educate them. In addition, the extensive programs of the National Science Foundation during the 1960s for the retraining of teachers after college no longer exist.

I have not dealt specifically with such educational constraints as school financing, the effects of declining school enrollments, teacher tenure, teacher salaries, and the broader purposes of general education. This is not an oversight and they must be considered at some point.

Science Education in Other Countries

Currently, most Communist and Third World countries are in the process of strengthening their precollege science and mathematics programs. While we may have little to learn from the science and technology programs of these countries, we cannot afford to ignore their educational and economic motives, goals, and institutions. The countries chosen for comment are the USSR, East Germany, the People's Republic of China, and

Japan. Each country has demonstrated that it is possible to redirect an educational system and to do so in a comparatively short time. In the 1940s these countries were either devastated by a war, losers in a war, or engaged in a civil revolution.

The topics selected for discussion either represent commonalities in the way science and mathematics are taught, or illustrate a unique characteristic of the educational program of a country. These selections should not be regarded as recommendations for American schools, but they might serve as departures for argument (42, 43, 44, 45).

- Each country is moving toward a 12-year program of public education. The school year averages 240 days, compared with 180 days in the United States; has a 5.5- or 6-day school week; and has a 6- to 8-hour school day. Time-on-task exceeds that of the United States on all grade levels. School vacations are short and dispersed throughout the year to minimize interferences with the learning sequence. Absence from school is minimal and is considered a family responsibility.

- National educational policies emphasize the importance of science and mathematics to economic and cultural progress. Knowledge of and about science and technology is considered a national resource, and all citizens have a "moral" responsibility to improve their knowledge of the sciences so they may better the welfare of the state. In China, science education policies are written into the constitution of the People's Republic.

- A knowledge of science and technology is considered essential for understanding and living in the modern world. Conversely, in the United States the emphasis is more on what a student wants to know than on what is important for advancing the nation's welfare.

- Instruction in science and arithmetic begins in the primary school. For the first three years all subjects are taught by one teacher. Specially trained science and mathematics teachers take over instruction in grade four and this is the pattern through all remaining grades until graduation from the secondary school.

- Specialized study in the sciences begins in the sixth grade with courses in mathematics, biology, chemistry, physics, and geography (earth science). These courses are required of all students. The courses meet one to three periods a week with changes in time patterns at different grade levels. Mathematics receives the most emphasis, followed by physics and chemistry. The time spent on these subjects, based on class hours, is approximately three times that of a student in the United States who would elect four years of science and mathematics in the secondary school.

- A student takes three or four sciences each term and they continue over several grades. This arrangement makes it possible to match subject matter with maturity level of the student, as well as to provide opportunities for integrative activities between disciplines, and reinforce learning from a past year. Science courses are uniform throughout the country although some time is available to supplement courses with topics of local concern.

- The secondary school program is a balance of science/mathematics courses with about an equal number of social science, language, and humanities courses. To accommodate the required curriculum, students must carry seven to nine courses per semester.

- English is regarded as the "language of science." With a knowledge of English it is possible to tap the world's largest source of scientific and technical information. Currently there are more students and adults learning English in China than there are English speaking people in the United States.

- Gifted or talented students in science and mathematics are encouraged by an array of activities such as national contests, research projects outside of school time, opportunities to talk with teachers, scientists, and mathematicians, and early admission to a university. In China there are "key" schools and universities which enroll only the very best students. The Japanese do not approve of gifted student programs; their attitude is that whatever is good for a gifted student is good for all students.

- In the Communist countries there are comprehensive examinations at the end of the primary, middle, and secondary schools to assess a student's total progress. Test results are not interpreted in a competitive sense as to who has done well or poorly compared to other students or a norm, but rather whether a student has mastered the prescribed subject matter. If test results are below expectancy, the student is tutored by the teacher and other students. The objective is to avoid failures.

- Vocational training, defined as the skills and knowledge essential for employment in specific occupations, begins in high school. At age 14-15 a student makes a choice to pursue either a vocational or college preparatory program. Of those students who qualify for entrance into a university, approximately 50 percent choose science or engineering as a career.

- Science and mathematics teachers are trained in specially designed programs in a university, pedagogical institute, normal school, or teachers college. The major part of the course work occurs in a science or mathematics department, and the course work parallels the subject matter of the textbook the future teacher will be using in the primary or secondary school. Russia requires science teachers to carry out a research project in their major field. The completed study is reviewed by a faculty committee similar to that for a doctoral dissertation. Each of these countries has provisions for a continuing program of in-service education. Local colleges and universities are expected to assume much of this responsibility.

- There are programs for developing a mass scientific and technological literacy in these countries. China has the greatest need and the most diversified program. A national symbol is the Bohr atom model with the slogan, "Science is the Eternal Spring." Japan is probably the most successful nation in attaining a high level of scientific literacy amongst its people; here broadcasters use scientific and technical terms where essential for an accurate reporting of science news.

- In these countries there is more parental concern, involvement, and responsibility for children's learning than is apparent in the majority of American families. This carries over to the students' interest in school. In an international study of 12 nations, including the United States and countries of Western Europe, Japanese children had the greatest love of schooling, and the highest level of academic achievement.

Summary

Among the developed and developing countries throughout the world there is widespread recognition of the importance of science and technology in fostering human well-being, and in meeting the economic and political demands of living in the twentieth century. For the United States to meet similar goals will require a knowledgeable and concerned public as well as specialists in the generation of scientific knowledge and technological innovations. The commitment of precollege education in the sciences and technology must be to the general public. There is a vast amount of scientific information that should be a part of human experience, not only for the intellectual insights it provides to the individual, but for its usefulness in advancing human welfare and the nation. To achieve a science education with these ends will require the cooperative endeavors of parents, scientists, engineers, government officials, school adminstrators, media specialists, and experts in the social sciences, and all others with a positive vision of America's future. These people will need to lay the groundwork for a school curriculum in the sciences and technology that has both scientific and cultural validity.

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HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION

Part 1

WEDNESDAY, SEPTEMBER 29, 1982

House of Representatives, Subcommittee on Elementary, Secondary, and Vocational Education and Subcommittee on Postsecondary Education, Committee on Education and Labor,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:40 a.m, in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the subcommittee) presiding.

Members present: Representatives Perkins, Andrews, Simon, Kildee, Peyser, Petri, and DeNardis.

Staff present: John F. Jennings, counsel; Nancy L. Kober, legislative specialist; William A. Blakey, counsel; Lisa Phillips, staff assistant; and Betsy Brand, minority legal assistant.

Chairman **Perkins**. This morning we are conducting a joint hearing on mathematics and science education. We heard persuasive testimony yesterday before the Subcommittee on Elementary, Secondary and Vocational Education about the crisis confronting our schools in the area of science and mathematics education.

This crisis is evidenced by declines in standardized test scores, a drop in the number of students studying advanced mathematics and science, and a shortage of teachers in these areas.

Many of these problems are related to the training of teachers and institutions of higher education, and for that reason, I am delighted Congressman Simon's subcommittee is joining us in examining these issues.

We have a number of bills pending before the two subcommittees to upgrade mathematics and science education or to increase the supply of teachers and to improve teacher training.

One of these bills, H.R. 6775, was introduced by our colleague, Congressman McCurdy, and Senator Glenn on the Senate side.

I am pleased that both of these sponsors are testifying this morning, and let me say, Senator Glenn, what a great pleasure it is to welcome you here.

If there is any individual in the United States qualified to testify in this area, I think it is you, and I do not know of anyone in the whole country who is better qualified to make a statement in this area. I have always admired your record here in the U.S. Senate and I think, for that matter, all the American people admire your record.

I am delighted to have you over here and you just proceed in any way that you want to. Go ahead.

Senator **Glenn**. Mr. Chairman, thank you very much.

Chairman **Perkins**. Excuse me, Mr. Simon, do you care to make a statement?

Mr. **Simon**. I will simply enter my statement in the record. I would note, Mr. Chairman, that on Monday, we will celebrate the 25th anniversary of Sputnik.

At that time, or immediately after that, there was a tremendous surge in math and science interest in the Nation. We are not going to have any such dramatic gesture now that will cause us to move ahead.

We have a serious problem. I have, frankly, not had a chance to read your bill, do not know whether this is the right answer or not, but we clearly have a problem that must be addressed and I applaud my colleague from Oklahoma and the good Senator from Ohio for their leadership on this.

If I may add just one personal note, Mr. Chairman, the Senator from Ohio is going to be in Carbondale, Ill., Saturday night for a slightly partisan event and he just offered to fly me out. I said, "Are you a reasonably good pilot?"

He said he carries along a little book, "How to Fly." I felt, with that assurance, that it might be safe to accept the invitation.

Chairman **Perkins**. Let me, in response, say one word about Sputnik. As I recall, it was put up on a Saturday evening. Sunday I was not here, but when we got back here on Monday, we had several meetings.

We had been trying to pass a general education bill for several years. In fact, we got one through the committee one time on a 13-to-12 vote, and Congressman Wardell of California changed his vote at the request of Mr. Nixon, who was on the committee then, and it was recorded 13 to 12 against us when the vote was announced.

John Luzinski held up the vote, we had a religious controversy going, so we struggled for years trying to get an educational bill.

But in those conferences in 1957, after Sputnik went up, I urged that we put everything in the National Defense Education Act that we possibly could to improve education, and that is what we did, we put in guidance and counseling and other things. If we had not done that it would have been 10 or 15 years thereafter before we could have passed many of those education programs that we put in the National Defense Education Act.

But, of course, the greatest thing we put in there was the national defense student loan program. That was the great advantage, it laid the foundation for better student aid legislation in the future.

Sputnik played the part that enabled us to get a major education bill enacted in 1958.

Mr. Peyser, do you have a statement you want to make?

Mr. **Peyser**. Just, Mr. Chairman, to say that I am glad that Paul's telling the story about Senator Glenn having the book on how to fly, I thought he was going to say "Fear of Flying," which is another book that was quite popular.

I do want to say that I welcome the Senator and our colleague from Oklahoma here and it is interesting to note, Senator, you may not have been aware, but about 6 or 7 weeks ago, the administration led the fight on the floor to knock the science education funds out of legislation that was there, and they succeeded.

And then I was given the opportunity of offering the amendment to reinstate those funds which then the House, recognizing what was going on, passed, and so this is a vital area and we are delighted that you are both here this morning.

Senator GLENN. Thank you.

Chairman PERKINS. Excuse me, Mr. DeNardis.

Mr. DENARDIS. Mr. Chairman, I am delighted to participate in these hearings. This is an extremely important subject, needless to say. As someone who taught at a small college for 16 years prior to my service in the Congress, I am very much aware of the deficiencies in this area.

I taught neither one of these disciplines under examination this morning, but we did train future teachers at the institution that I was associated with so I am very much interested in the bills that are pending.

Let's go forward.

Chairman PERKINS. Go ahead, Senator.

STATEMENT OF HON. JOHN GLENN, A U.S. SENATOR FROM THE STATE OF OHIO

Senator GLENN. Thank you, Mr. Chairman, very much, and I don't know, Congressman Simon, that I would say that we celebrate Sputnik; maybe that is the wrong choice of words.

We do note the anniversary of Sputnik. I am sure that some of the difficulties we have today may in part go back to those days, because we began an emphasis on science and education at that time; after sputnik, we were very worried about the situation, but then didn't follow through.

Now we are at the other end of that curve, we are at the lower level, and the bills that we have introduced are not designed to be any panacea for the whole thing, they are a little nibble at what is a very big problem that we are going to have to work on for a number of years.

Mr. Chairman, I thank you very much for the invitation to testify before this subcommittee on the two bills concerning science and mathematics education, which I was proud to author and work on with Congressman McCurdy and introduce on the Senate side on July 15 of this year.

I am pleased to be at this hearing with Congressman Dave McCurdy; he has been working hard on this side of the Capitol to move these bills along and this hearing is testimony to his efforts in that regard. So we are working as a team on this.

I am also specifically pleased to be here before you, Mr. Chairman, personally, because in your long and continuing role as chairman of this committee, you have made more contributions to education and to precollege education in particular in the United States, than probably any other single person in this Congress, and I believe you will be long remembered for it.

Mr. Chairman, in 5 days, we will have the 25th anniversary of the launching of Sputnik that took place on October 4, 1957.

That event shocked many Americans because we had assumed up to that point that the United States was the undisputed technological leader of the world in almost all fields, and particularly in the area of rockets and space.

In retrospect, having been beaten by the Russians in launching the first satellite was not all bad because it galvanized our Nation to rededicate ourselves to becoming first in space and, more generally, to improve our science and techonology, particularly with emphasis on producing more advanced technical manpower as well as improving science education in our schools.

As we regained our technological lead in space, however, our efforts in other areas began to flag. And thus was begun a slide downward in education, research, and development and finally, after 1969, a decline in the space program itself.

We need to be concerned about all of these areas, but Mr. Chairman, I wish to stress today my particular concern about the state of science and math education at the precollege level in the United States today and some of the steps we ought to be taking, in fact, we must take, in order to do something about it.

Let me begin by saying that we would all agree that the role of science and technology is increasing throughout our society.

In business, in government, in the military, in occupations and professions where it had never before intruded, science is becoming a key to success.

Unfortunately, our educational system is not providing the kind of understanding of science and technology that is needed for our young people to enter the work force in jobs associated with companies exploiting high technology.

Students who take no more mathematics and science after their 10th year in school have effectively eliminated, by the age of 16, the possibility of science or engineering as a career.

We are in danger of drawing down the pool from which our future scientific and engineering personnel will come, even as the need for such personnel is increasing.

The declining emphasis on science and mathematics in our school systems is in marked contrast to other industrialized countries.

Japan, Germany, and the Soviet Union all provide rigorous training in science and math for nearly all their students at the precollege level.

Let me give just a few examples. In Japan, for example, about 25 percent of classroom time in grades seven through nine is spent on mathematics and science courses—25 percent of classroom time.

In upper secondary school, nearly all of the college-bound students—and that is roughly one-third of the total of all students in Japan—take three natural science courses and four mathematical courses, including calculus, during their 3-year high school career.

In Japan, geometry is taught in the seventh, eighth, and ninth grades; trigonometry is also studied in the ninth grade; calculus, probability, and statistics are offered in high school.

In Germany, the general preparation is similar. For those headed toward college, science begins early. In the fifth grade, in Germany, students take chemistry and physics as lab courses, as well as biology.

Each is studied 2 to 3 hours a week. It is also at this level that geometry is introduced. The overall picture in Germany is one of a very high level of science and mathematics literacy among college students, as well as a strong science/mathematics understanding among the whole general population.

While the situation in the Soviet Union is less clear, there is no question that their school curricula is very heavily laden with science and mathematics. One professional observer believes that the mathematical and science curricula in the Soviet schools surpass that of any other country, including the United States.

Algebra and geometry are taught in the sixth and seventh grades in the Soviet Union. Advanced algebra and trigonometry are taught in grades 8 through 10, and calculus, which a total of about 500,000 Americans take during the last year in high school or first year in college, is part of the high school curriculum for over 5 million Soviet students.

In addition, all youngsters are required to complete 5 years of physics, 4 years of chemistry, and up to 4 of biology.

This is not to say that the Soviet Union does not have some major educational problems, but the results are there for all to see.

The Soviet Union is reputed to have graduated over 300,000 engineers last year, while the United States graduated 65,000. Japan, which has half our population, graduated 80,000 engineers.

The demand for engineers and technical people of all types in the United States has become so large that it is creating educational problems in its own right. Our engineering graduate schools are filled with foreigners who, last year constituted 46 percent of our engineering Ph. D. graduates in the United States.

Two-thirds of those were here on temporary visas. The high salaries being paid to people graduating with baccalaureate degrees in engineering has caused a decrease of 40 percent in the number of Ph. D.'s in electrical engineering awarded over the past 10 years.

This inability to meet the need is highlighted by the fact that, whereas 20 percent of Japan's undergraduates major in science or engineering, and 35 percent of Germany's undergraduates major in those subjects, in the United States, only 6 percent of our undergraduate students major in engineering—6 percent.

Our schools are not doing the job that needs to be done of motivating young people to go on to careers or at least become highly literate in science and mathematics.

Part of the reason is the lack of qualified teachers in those subjects at the precollege level. If this situation continues, we will not only fail to meet the needs of the Armed Forces and the industrial and public service enterprises in the United States, but we will widen the gap between public understanding of science and technology and the requirements of citizenships in a participatory democracy.

Only half the States in the United States require at least one science course before high school graduation. That is a shocking fact to me; only half the States in the United States require one science course before high school graduation and in about half of these States, the course can be either physiology or health and hygiene.

Five States require two or more science courses and the rest mandate none. Local school districts may make up some of that, but these are the State requirements.

Since 1960, the average achievements scores in science and mathematics on a variety of test instruments have shown a steady decline.

The mean SAT score in math has dropped from 502 in 1963 to 466 in 1980, although it came up slightly last year. The proportion of students scoring above 700 on the SAT mathematics test declined 15 percent over an 8-year period, from 1967 to 1975.

During the same interval, students scoring below 300, below 300 on the mathematics section, increased 38 percent.

So the evidence is that we are not going to meet our needs for qualified science and math teachers to turn this situation around, unless some action is taken. A survey taken by the National Science Teachers Association shows that there has been a 68-percent reduction in newly employed science teachers and 80-percent reduction in newly employed math teachers since 1971.

Another survey of secondary school principals showed that among newly employed science and math teachers, more than 50 percent were unqualified to teach science or math.

They were employed on an emergency basis because no qualified teachers could be found. Compounding this problem is the fact that schools have an aging faculty and that one in four of the younger faculty in science and math plan to leave teaching completely.

Almost five times more science and math teachers left teaching last year for employment in nonteaching jobs than left due to retirement.

If the present exodus of qualified science and math teachers from secondary schools continues, the Nation will have a net loss of 35 percent by 1992, just in the next decade.

Twenty-five States presently, half of the United States, 25 States presently have a critical shortage of high school physics teachers and 20 States critically need math and science teachers.

Yet, in New York, the Nation's second most populous State, only 32 1982 college graduates indicated they were planning to teach junior or senior high school math, only 32 in the whole State of New York.

The State University of New York at Albany, with over 15,000 students, has not graduated a physics teacher for 6 years.

In New Hampshire, only one college graduate this year is planning a career teaching mathematics, according to a State department of education spokesman.

It is fair to ask in the face of this apparently calamity, what the Reagan administration's response has been. As far as I can tell, its response has consisted of two steps. First, the President's budget for fiscal year 1983 zeroed out all funds for science education except for graduate fellowships.

Second, the President asked the National Science Foundation to set up a Commission on Pre-College Science and Math Education to tell us what the problem is, and what ought to be done about it in 16 months.

Now I certainly have great respect for the members of that Commission and I shall look forward to their report with anticipation, but I do not believe, Mr. Chairman, we need to wait any 16 months to decide that we have a problem and that something ought to be done about it.

We already know what some of the major problems are and we can take some action now.

It was with all of this as a background, Mr. Chairman, that I introduced on the Senate side, S. 2737, the Pre-College Mathematics and Science Teacher Assistance Act; and S. 2738, the Math and Science Education Act.

S. 2737 authorizes an educational assistance program consisting of low-cost, forgiveable loans to college students who will major in science or mathematics and will go on to teach, go on to teach, at the precollege level.

These 7 percent interest loans are forgiveable over a 4-year period of teaching, if they stick with the teaching.

The next bill, S. 2738, provides for a 50-percent tax credit to employers who hire precollege science and math teachers for the summer months and give them experience in the applications of high technology.

A similar tax credit is also available to any firm which gives a qualified and certified employee a certain amount of time off to teach science and mathematics in the public school system.

Mr. Chairman, the program in S. 2737 will help us increase the number of well-prepared students in science and math to go on as teachers at the precollege level. It would show that this is a high national priority.

It could encourage students to pursue mathematics and science teaching careers instead of more lucrative job opportunities in industry. It could have the effect of becoming part of a total financial aid package that would permit some students to attend school who might be unable to attend without this additional assistance.

As for S. 2738, I believe that it is time for government and business to get together in a cooperative effort, to improve our school system, since both are major beneficiaries of those systems.

The industrial sector of our economy has given and is giving significant support relative to the past to science and engineering training at the college level.

But help for elementary and secondary schools has been sporadic at best. The role that industry could play is evidenced by the positive impact that has been had in the elementary schools which have had science specialists to call upon.

If every elementary school had a competent science specialist to serve as both teacher and resource person, science education would very definitely be improved.

Some far-sighted corporations like Monsanto have been active in these areas and I certainly applaud them for it. They saw a need and they went to fill that need. So Monsanto should be complimented for it.

But much more can and should be done. I believe the tax credit incentives in S. 2738 will induce many more corporations to make a positive contribution to resolving our science and math education problems.

The tax credits will provide incentives to hire science and math teachers for the summer, thereby giving them a source of income that will allow them to stay within the school system. And since the bill specifies that they are to be engaged in some work involving applications of high technology, it will also give these teachers some additional experience that they can bring back to the classroom.

The provision of tax credits for giving qualified and certified employees release time to teach in the public school system will enable the schools to find the resource specialists that they need, as well as to get some of the better science and math teachers that may have left the system for jobs in private industry to go back to the school system, at least on a part-time basis.

Mr. Chairman, I believe deeply in the two bills we are discussing today. I think they can be an important first step toward meeting the overall need of restoring the U.S. educational system to a level where our young people will once again be given the best opportunity, not only for economic success, but for realization of their fondest hopes regarding their own development as human beings in our society.

Mr. Chairman, in an article in the New York Times on August 3 of this year, 1982, the Times education reporter, Fred Hechinger, interviewed John Gardner, former Secretary of Health, Education, and Welfare, and former president of Common Cause.

Mr. Gardner predicted that education would, after almost two decades of popular neglect, become a major issue in the 1984 Presidential campaign.

I would like to say, Mr. Chairman, I believe, along with the American people, that education deserves to be among the top issues in our domestic agenda.

If the administration continues to approach these problems with just more commissions and more studies and more excuses for not doing anything, then I think Mr. Gardner will indeed be proven right, and this is going to be an increasingly important issue.

I would only add to that statement, Mr. Chairman, that I think the United States became a great nation for three very basic reasons.

First, we started out to educate all of our people. We gave them all the education they could take and as much higher education as they could take. And out of that came an educated citizenry, an educated work force, and more people going on to higher education than any other nation around the world.

Second, we put more investment into research, inquiry into the unknown, basic inquiry. We did much of this from a governmental level, and out of that came the new facts, the new basic research breakthroughs that left us ahead of the rest of the world. And with a free enterprise system waiting to pounce on those new ideas and make a buck with them, here and around the world, we progressed.

The first step in that whole process that has made this country what it is, is based very firmly in education. We are finding those roots, it seems to me, being poisoned today with some of the things going on.

These bills that we are proposing, Mr. Chairman, certainly are no panacea, they are no answer to the overall problems in education, but they are a first step in at least trying to get some qualified people back into our schools to teach our young people.

Thank you very much.

[The prepared statement of Senator John Glenn follows:]

Prepared Statement of Hon. John Glenn, a U.S. Senator From the State of Ohio

Mr. Chairman, thank you for the invitation to testify before this subcommittee on two bills concerning science and mathematics education, which I was proud to author and to introduce on the Senate side on July 15, of this year. I am pleased to appear at this hearing with Congressman Dave McCurdy who is working hard on this side of the Capitol to move these bills along, and this hearing is testimony to his efforts in that regard. I am also specifically pleased to be here before you Mr. Chairman, because in your long and continuing role as the Chairman of this Committee, you have made more contributions to pre-college education in the United States than anyone else in the Congress, and I believe you will long be remembered for it.

Mr. Chairman, in five days we will have the 25th Anniversary of the launching of Sputnik I that took place on October 4, 1957. That event shocked many Americans because we had assumed up to that point that the United States was the technological leader of the world in almost all fields, and particularly, in the area of rockets and space. In retrospect, having been beaten by the Russians in launching the first satellite was not all bad because it galvanized our nation to rededicate ourselves to becoming first in space and more generally, to improve our science and technology, particularly with emphasis on producing more advanced technical manpower as well as improving science education in our schools. As we regained our technological lead in space, however, our efforts in other areas began to flag. And thus was begun a slide downward in education, research and development, and finally, after 1969, a decline in the space program itself. We need to be concerned about all of these areas Mr. Chairman, but I wish to stress today my particular concern about the state of science and mathematics education at the pre-college level in the United States today and some of the steps we ought to be taking to do something about it.

Let me begin by saying that we would all agree that the role of science and technology is increasing throughout our society. In business, in government, in the military, in occupations and professions where it never before intruded, science is becoming a key to success. Unfortunately, our educational system is not providing the kind of understanding of science and technology that is needed for our young people to enter the work-force in jobs associated with companies exploiting high technology. Students who take no more mathematics and science after their tenth year in school have affectively eliminated, by the age of sixteen, the possibility of science or engineering as a career. We are in danger of drawing down the pool from which our future scientific and engineering personnel will come even as the need for such personnel is increasing.

The declining emphasis on science and mathematics in our school systems in marked contrast to other industrialized countries. Japan, Germany, and the Soviet Union all provide rigorous training in science and mathematics for nearly all their students at the pre-college levels. In Japan for example, about 25% of classroom time in grades 7-9 is spent on mathematics and science courses. In upper secondary school, nearly all of the college-bound students (roughly one-third of the total) take three natural science courses and four mathematics courses, including calculus, during their three-year high school career. In Japan, geometry is taught in the 7th, 8th, and 9th grades. Trigonometry is also studied in the 9th grade. Calculus, probability, and statistics are offered in high school.

In Germany the general preparation is similar. For those headed toward college, science begins early. In the 5th grade students take chemistry and physics as lab courses as well as biology. Each is studied 2–3 hours a week. It is also at this level that geometry is introduced. The overall picture in Germany is one of a very high level of science and mathematics literacy among college graduates, as well as a strong science/mathematics understanding among the general population.

While the situation in the Soviet Union is less clear, there is no question that their school curricula are very heavily laden with science and mathematics. One professional observer believes that the mathematics and science curriculum in the Soviet schools surpasses that of any other country including the U.S. Algebra and geometry are taught in the 6th and 7th grades, advanced algebra and trigonometry are taught in grades 8–10, and calculus, which a total of about 500,000 Americans take during their last year in high school or their first in college, is a part of the high school curriculum for over 5 million Soviet students. In addition, all youngsters are required to complete 5 years of physics, 4 of chemistry, and up to 4 of biology.

This is not to say that the Soviet Union does not have some major educational problems, but the results are there for all to see. The Soviet Union is reputed to have graduated over 300,000 engineers last year while the United States graduated 65,000. Japan, which has half our population, graduated 80,000 engineers.

The demand for engineers and technical people of all types in the United States has gotten so large that it is creating educational problems in its own right. Our engineering graduate schools are filled with foreigners who last year, constituted 46 percent of our engineering Ph.D. graduates in the United States. Two-thirds of those were here on temporary visas. The high salaries being paid to people graduating with baccalaureate degrees in engineering has caused a decrease of 40 percent in the number of Ph.D.'s in electrical engineering awarded over the past 10 years. This inability to meet the need is highlighted by the fact that, whereas 20 percent of Japan's undergraduates major in science or engineering, and 35 percent of Germany's undergraduates major in those subjects, in the United States, only 6 percent of our undergraduate students major in engineering.

Our schools are not doing the job that needs to be done of motivating young people to go on to careers or at least become highly literate, in science and mathematics; and part of the reason is the lack of qualified teachers in those subjects at the pre-college level. If this situation continues, we will not only fail to meet the needs of the armed forces and the industrial and public service enterprises in the United States, but we will widen the gap between public understanding of science and technology, and the requirements of citizenship in a participatory democracy. Only half the states in the United States require at least one science course before high school graduation and in about half of these states, the course can be either physiology or health and hygiene; five states require two or more science courses and the rest mandate none. Since 1960 the average achievements scores in science and mathematics on a variety of test instruments have shown a steady decline. The mean SAT score in mathematics has dropped from 502 in 1963 to 466 in 1980, although it came up slightly last year. The proportion of students scoring above 700 on the SAT mathematics test declined 15 percent over an eight-year period, 1967–1975. During the same interval, students scoring below 300 on the mathematics section increased 38 percent.

The evidence is that we are not going to meet our needs for qualified science and math teachers to turn this situation around unless some action is taken. A survey taken by the National Science Teachers Association shows that there has been a 68 percent reduction in newly employed science teachers and 80 percent reduction in newly employed math teachers since 1971. Another survey of secondary school principals showed that among newly employed science and math teachers, more than 50 percent were unqualified to teach science or math. They were employed on an emergency basis because no qualified teachers could be found. Compounding this problem is the fact that schools have an aging faculty and that one-in-four of the younger faculty in science and math plan to leave teaching completely.

Almost five-times more science and math teachers left teaching last year for employment in non-teaching jobs than left due to retirement. If the present exodus of qualified science and math teachers from secondary schools continues, the nation will have a net loss of 35 percent by 1992. Twenty-five states presently have a critical shortage of high school physics teachers and twenty states critically need math and science teachers. Yet, in New York, the nation's second most populous state, only thirty-two 1982 college graduates indicated that they were planning to teach junior or senior high school math. The State University of New York at Albany, with over 15,000 students hasn't graduated a physics teacher for six years. In New Hampshire, only 1 college graduate this year is planning a career teaching mathematics according to a State Department of Education spokesman.

It is fair to ask in the face of this apparent calamity, what the Reagan Administration's response has been. As far as I can tell, its response has consisted of two steps. First, the President's budget for fiscal year 1983 zeroed out all funds for science education except for graduate fellowships. Second, the President asked NSF to set up a Commission on Pre-College Science and Math Education to tell us what the problem is, and what ought to be done about it in sixteen months. I have great respect for the members of that Commission and I shall look forward to its report with anticipation, but I do not believe we need to wait sixteen months to decide that we have a problem and that something ought to be done about it. We already know what some of the major problems are and we can take action now.

It was with all of this as a background, Mr. Chairman, that I introduced on the Senate side S. 2737, The Pre-College Mathematics and Science Teacher Assistance Act; and S. 2738, The Math and Science Education Act. S. 2737 authorizes an educational assistance program consisting of low-cost, forgiveable loans to college students who will major in science or mathematics and will go on to teach at the pre-college level. These 7 percent interest loans are forgiveable over a 4-year period of teaching. S. 2738 provides for a 50 percent tax credit to employers who hire pre-college science and math teachers for the summer months and give them experience in the applications of high technology. A similar tax credit is also available to any firm which gives a qualified and certified employee a certain amount of time off to teach science and mathematics in the public school system.

Mr. Chairman, the program in S. 2737 will help us increase the number of well prepared students in science and math to go on as teachers at the pre-college level. It would show that this is a high national priority. It could encourage students to pursue mathematics and science teaching careers instead of more lucrative job opportunities in industy. It could have the effect of becoming part of a total financial aid package that would permit some students to attend school who might be unable to attend without the additional assistance.

As for S. 2738, I believe it is time for government and business to get together in a cooperative effort to improve our school systems since both are major beneficiaries of those systems. The industrial sector of our economy has given, and is giving, significant support relative to the past to science and engineering training at the college level, but help for elementary and secondary schools has been sporadic at best. The role that industry could play is evidenced by the positive impact that has been had in those elementary schools which have had science specialists to call on. If every elementary school had a competent science specialist to serve as both teacher and resource person, science education would very definitely be improved. Some far-sighted corporations like Monsanto have been active in these areas and I applaud them for it, but much more can and should be done.

I believe the tax credit incentives in S. 2738 will induce many corporations to make a positive contribution to resolving our science and math education problems. The tax credits will provide incentives to hire science and math teachers for the summer, thereby giving them a source of income that will allow them to stay within the school system. Since the bill specifies that they are to be engaged in some work involving applications of high technology, it will also give these teachers some additional experience that they can bring back to the classroom. The provision of tax credits for giving qualified and certified employees release time to teach in the public school system will enable the schools to find the resource specialists that they need, as well as to get some of the better science and math teachers that may have left the system for jobs in private industry, to go back to the school system, at least on a part-time basis.

Mr. Chairman, I believe deeply in the two bills that we are discussing today. I believe they can be an important step toward restoring the U.S. educational system to a level where our young people will once again be given the best opportunity, not only for economic success, but for realization of their fondest hopes regarding their own development as human beings in our society.

Mr. Chairman, in an article in the New York Times on August 3, 1982, the Times education reporter, Fred Hechinger, interviewed John Gardner, former Secretary of Health, Education, and Welfare and former President of Common Cause. Mr. Gardner predicted that education would, after almost two decades of popular neglect, become a major issue in the 1984 Presidential campaign. I would like to say, Mr. Chairman, that I believe, along with the American people, that education deserves to be among the top issues in our domestic agenda. And if the Reagan Administration continues to approach these problems with more commissions, more studies, and more excuses for not doing anything, then I believe Mr. Gardner will be proven right and that the 1984 Presidential campaign will, indeed, have education as a major issue.

Thank you very much.

Chairman PERKINS. Thank you for excellent testimony. It seems to me that one of our major problems is to attract bright, young students to become science and math teachers and then to keep them in the school after they go into teaching.

The additional problem seems to be that industry, of course, draws them out of the school by offering higher salaries.

How would your bill help us solve that problem?

Senator GLENN. What we do, Mr. Chairman, is with 2737, the Pre-College Mathematics and Science Teacher Assistance Act, what we try and do with it is we provide forgiveable loans, low-cost loans, to people willing to go into school and then go into teaching and stay in teaching.

They would be forgiven, of course, part of their loan for each year they stayed in the teaching profession. This is a partial answer, obviously this does not automatically make them immune to being attracted out some time in the future, but at least if we attract them into the teaching profession and keep them there for that 4-year period, perhaps they will have a tendency to stay in beyond that time period.

Chairman **Perkins**. Go ahead.

Mr. **Andrews**. Do you know how many States already have a program such as this?

Senator **Glenn**. I don't have any statistics on that.

Mr. **McCurdy**. Two.

Senator **Glenn**. Just two?

Mr. **McCurdy**. I believe Alabama and Kentucky have. Don't they have a forgiveable loan program in Kentucky.

Mr. **Andrews**. North Carolina does.

Chairman **Perkins**. Mr. Simon.

Senator **Glenn**. I am told by staff, though, that some programs are not targeted to science and math, so they would not address the specific problem we are faced with here.

Mr. **Simon**. Illinois would have the more general provision, also. Just one comment, and then one question.

To add to that list of statistics which is most impressive, in the Soviet Union when you graduate from secondary school, you have 4 years of physics. In the United States, 16 percent of our high school graduates have 1 year of physics. Again, we are in a competitive world, we have to recognize that.

Senator **Glenn**. And, I would add, in many instances, it can be a hygiene course. If you know when to wash your hands during the day, you have become eligible to graduate from high school as far as science is concerned.

Mr. **Simon**. Let me ask this question. I have heard some criticism of this approach on the basis that what we are going to do is the same kind of thing we did after Sputnik and that what the nation needs is not only good teachers of physics or chemistry or math, but good English teachers, and a variety of other things.

How do you respond to that particular criticism?

Senator **Glenn**. I think this is just a situation we see that this is the most critical right now. I would agree with those who say that we do not put nearly enough into our school system in all different levels. Social sciences, physical sciences, all levels of education.

I think it is tragic, some of the cutbacks. We have not kept up and we just see this particular area as being the most critical right now. When you get down to the point where people are going to be basically functional illiterates in math and science unless we reverse this trend, we have an acute situation. In a world which is increasingly more oriented toward the industries of the future being based in science and math, falling behind in education means we are limiting the potential for the future of our country.

I think we no longer can afford the complacency of just saying as we have ever since World War II, we are the superior nation and we just presume we will go on into the future being the superior nation.

That worked OK. That was fine as long as other nations were still sort of recovering from World War II and trying to get their act together, as it were.

And now they have recovered, and they have enough disposable national income now that they are now channeling more of it into education, more of it into science research in these areas and are beginning for the first time to out compete us in certain areas.

We now import about a quarter of our cars from Japan. That is no accident. They put out a very good product and it is a very fine technologically advanced product and that is good.

That was not true up until just the last few years. But we have now seen some 2 million American jobs in effect exported overseas as other nations begin for the first time since World War II to truly outdo us in certain areas of production, productivity, advanced technology, high-tech areas. Unless we reverse this trend, that 2 million jobs exported is going to be just the first wave.

We are going to see many more millions added to it unless we reverse this trend, and I am not saying that passing these two bills is going to take care of that problem. It certainly is not, but these are two first steps we can make.

Mr. **Simon**. Thank you very much, thank you, Mr. Chairman.

Chairman **Perkins**. Mr. DeNardis.

Mr. **DeNardis**. Thank you, Mr. Chairman.

Senator Glenn, one of your bills and the companion bill introduced by Congressman McCurdy would grant tax credits to firms that hire teachers during the summer.

This is a very laudible goal permitting a very important change to take place. However, I think it could be said that the bill might be deficient in at least one respect, and that is by allowing the teacher a paid opportunity to learn whether he or she not prefer private-sector employment, we might be doing the teaching profession ultimately a disservice.

Could you address this possibility?

Senator **Glenn**. I could and you have hit at a very key part. We discussed very long and seriously and debated whether this might not lose us more than we gain. We think that we will probably gain more than we will lose with this.

We hope that most of the people going into this program would probably be the ones that would be the beneficiaries of the loans under the one act, and then would take advantage of the opportunity under the second.

I will not say that we would have locks on them because of the first fact, but the tendency would be to keep them in their teaching jobs during that period.

The advantage is that it gives them some extra income during the summer, but it does something else. It gives them hands-on experience in a factory or a laboratory in a research situation where they can really bring a better background back to their teaching profession.

We hope that is the way it will work out. We talked about this a lot and I will be watching it very closely and you have put your finger on something I think we will have to watch very carefully.

Mr. **DeNardis**. Might we at least consider deleting the tax credit if the teacher stays with the private firm and does not return to education? Not that it will stop the teacher, but it might be something to consider.

Senator **Glenn**. It would be and I would have to look at that one little bit. I don't know whether you discourage—maybe you discourage the firms enough from starting into the programs if you do that. It might defeat the purpose of the whole thing.

But your concerns are my concerns, also, and we will have to watch this very carefully.

Mr. **McCurdy**. If the gentleman would yield, I think one of the concerns that you have is that you would be draining—I think there is testimony later this morning from some of the people within industry who will indicate that they have a number of employees who are qualified, but because of State requirements cannot teach on a part-time basis, who would love to take some time and to be able to help their children, as well as ours, by providing some on-hand experience, or hands-on experience, in the educational system, and I think we would see that there are a number of dedicated professionals out there who would love to be teachers that just quite frankly cannot afford the sacrifice financially.

Senator **Glenn**. This is two ways in the bill, you know, it is not only to get teachers on during the summer, but also to get firms to release employees to go teach for a while, too. It is both directions.

Chairman **Perkins**. Mr. Andrews.

Mr. **Andrews**. Thank you, Mr. Chairman. I would just like to concur in what has been said. I think it is an excellent presentation and I am one among us who is very supportive of the bills. I agree with some of the observations that are made and the response that was given, that perhaps they can be improved upon as we go along, but the objective, I think, is a most excellent one and I think that this generally is certainly the right approach.

We will have Dr. Paul Taylor from the Department of Public Instruction in North Carolina testifying later. North Carolina has already gone down this road a considerable way and I believe he can enlighten us as to whether, in fact, it has worked and has not worked and some innovations that have been made there along these lines.

I thank you very much for letting us benefit from your comments.

Chairman **Perkins**. Mr. Petri.

Mr. **Petri**. Just very briefly, I would like to agree and thank both gentlemen for the bills, but I would be curious to know how you would respond to the question that is probably sure to come up, and that is that we do have a marketplace out there and if there is a need for more teachers in science, students and others will quickly identify that if they want jobs. We had a teacher surplus before in some areas and we have had a scientist surplus at one point, too, and no sooner does the Government come in and identify it and set up a program, than we end up spending a lot on administrative costs and are a couple days late. We are taking from one area as we move into another.

The two questions are, what are we adding to what the market will, in fact, do; and second, if we do deploy resources into this area, where are we wasting resources now that we should spend less on?

Because clearly, the resources are not going to come from the Moon, they are going to be coming from someone else who will get less if we provide these incentives for science teachers.

Senator GLENN. Well, the amounts we are talking about are not that huge, at least in the first year or two of the program, 10 million or so, estimates of something like that, which is not a tremendously huge amount.

But I think the way I see the program is that I think eventually, let's say 7, 8, 10 years down the road, I have no doubt there will be a gradual swing back in this direction.

I look at this as seed corn. This is trying to just get the teacher corps together and get a teaching base together there that has reached an abysmally low level right now. It just seems to me that we have to do something to get this started.

When you look at the facts and figures of what has happened in science and industry and new technology and the move to Japan, the move to Europe, we are not being competitive.

We are not setting up the educational base for it. I don't think we have the luxury of waiting another 7 or 8 years for the natural market forces to provide that for us.

This is a very modest program, as I see it, which just sets the seed corn, the teacher corps that is going to absolutely be necessary if we are even going to have a capability of being competitive in the future and does nothing more than that.

Chairman PERKINS. Let me say, Senator, that our first fight next year is going to be to get room within this budget resolution so that we can enact a bill and then I want to go with you all the way. I suspect the majority of the members on this committee will go with you all the way. Mr. Simon, who has been a most outstanding member on the Budget Committee tells me that he will not be there next year.

We have got some other members on the Budget Committee who will look after the interests of the Committee on Education and Labor. You will have to do the same on your side and we will do our darndest to enact this legislation next year.

I think it is very necessary if we are going to keep up our modern technology and regain our technological edge in the international market. A lot of jobs and a lot of our principal industries have gone overseas.

We have got to regain that technology and leadership. I think this is one way to do it.

Thank you very much, we appreciate your being here this morning.

Senator GLENN. Thank you very much, Mr. Chairman.

I do have another hearing I do have to go back to, it started at 10 o'clock, as a matter of fact. Nuclear proliferation matters, which are also of great interest to all of us.

Chairman PERKINS. All right.

Senator GLENN. Let me just say this. The members of this committee here, and you in particular, Mr. Chairman, have been noted, as I said at the outset of my statement, for your interest and your long, continued work in this field.

I would welcome the opportunity to work with members of this committee, with you on either side of the aisle on these matters of education. I say that with every bit of sincerity because I think it is critical for the long-term future of this country.

Chairman **Perkins**. We will get together early next year—we are starting now—and see if we cannot accomplish something.

Senator **Glenn**. I mentioned those three little things—they are not little, they are major things—that have made this country what it is. And I think education is so key at the bottom of that ladder to everything else we do and then we are concentrating on math and science here, but our whole support for the educational system is something we really have to look at very, very carefully over the next few years.

So I thank you very much for you courtesy this morning. Thank you.

Chairman **Perkins**. Thank you.

Now, Mr. McCurdy, we are delighted to welcome our own colleague here this morning, who likewise has introduced similar legislation. We will hear from you now, representing the Fourth District in Oklahoma.

STATEMENT OF HON. DAVE McCURDY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OKLAHOMA

Mr. **McCurdy**. Thank you, Mr. Chairman.

I have a statement I would like to have entered into the record and, if I may, I will summarize the key points.

Chairman **Perkins**. Without objection, your prepared statement will be inserted into the record.

Mr. **McCurdy**. Thank you, Mr. Chairman.

I think I will just take the opportunity, rather than go over my statement again, to perhaps address some of the specific concerns that were raised in Senator Glenn's very eloquent statement, and highlight some of the points that we, as legislators who have to respond to local concerns, might take home with us.

I might state from the outset, that since I am a member of the Science and Technology Committee, and also the Armed Services Committee, and am not a member of the Education and Labor Committee, I do not want to assume or to invade the providence of the Education and Labor Committee, by any means.

I want to assure you that I believe this is the proper committee and that you have the proper insight and information to deal with this issue. However, as a member of those two other committees, I want to express the concerns that we have and the information that we have seen in those areas that address this also, and that, I think, highlight the critical nature of the problem that we are facing.

Last May I had an opportunity to chair a Science, Research and Technology Subcommittee hearing on precollege math and science education in my home district, in Norman, Okla.

Again and again, we heard the same thing: there are not enough math and science teachers and too many of those that are teaching are not qualified.

Let me just go over quickly the results of an Oklahoma State Department of Education statewide survey, which I found to be appalling.

Fifty percent of Oklahoma science teachers are not qualified to teach math and science. In the fall semester of 1981, only 15 college students took the math and science teacher competency test. Yet the State anticipates at least 250 vacancies in math and science teaching this year.

Over the last 10 years, there has been a 64-percent drop in the number of Oklahoma students completing mathematics teacher certification programs. One superintendent said that three out of four of his science teachers are physical education instructors.

Another superintendent has 50 applications on file for a science teaching position, but none of the applicants is certified to teach science or math.

Still another superintendent conducted a three-State search for a well-qualified science teacher, but was unable to find one. Only 51 percent of Oklahoma students have taken geometry; 87 percent have never taken trigonometry; 96 percent have had no precalculus or calculus.

We have seen in the Armed Services Committee, and I chair the Special Panel on Defense Procurement, and in testimony we had there, we have seen a critical shortage of engineers in the military, and the effects it has on the basic military readiness.

Of 1,574 artillery crew members tested, 86 percent were below the minimum level of skill required by Army standards for combat readiness. Of 385 nuclear weapons maintenance specialists tested, 90 percent flunked. Of 371 tank turret and artillery personnel tested, 98 percent failed. A random sampling of nearly 1,300. M-60 tank crew members found approximately one-fourth did not know where to aim when using their battle sights.

Of 1,633 Army computer programmers tested, 77 percent failed to meet minimum standards. You can see across the board, I don't care if it is in education, in industry, in the military, we are failing in a dramatic way.

You have heard time and time again, the comparisons internationally between the competency of our students and our illiteracy, scientific illiteracy, and the gains that the Senator mentioned in Japan and Germany and the Soviet Union.

Perhaps one statistic about the situation can, I think, address the question Mr. Petri had about—or maybe it was Mr. DeNardis—about the marketplace being able to respond.

In Oklahoma, again, data from one of the teaching universities there on the number of students completing the teacher education or certification program: In 1972, 26 graduates; in 1973, 15; in 1974, 12; in 1975, 9; in 1976, 5; in 1977, 6; 1978, 5; 1979, 2; and in 1980, 1. From 26 to 1 in just one university alone.

So I think when we talk about the marketplace and the market forces, having studied economics in graduate school and understanding that I do not understand those forces very well, but understanding that there is the marketplace there, and that it does operate, when you compare the statistics where a teacher on the average makes $13,000 teaching math and science, and can go out in industry and start for $20,000 to $25,000, the market force is working against us in the education sector.

So it is important that we provide some type of bonus. The largest newspaper in central Oklahoma has want ads running today for math and science teachers in the public schools.

It is a very pressing and a very scary problem and one that I think we have to address. But again, the bills that we have introduced, I think are unique in that we are trying to incorporate and develop the cooperation of industry, also the cooperation of the private sector, the educational sector, and the government.

We are not trying to throw money at a problem, we are trying to get people in industry involved in the solution. In our State alone, and I find it very interesting because they do not always work closely with some of the things that you and I are concerned with, the Oklahoma State Chamber of Commerce has endorsed our bill.

A number of private businesses have expressed strong interest. You will receive testimony today from associations that have endorsed and strongly support this legislation. The universities and school districts in Oklahoma that participated in our hearing and forum support the bill, the National Association of Secondary School Principals, the National Council of Teachers of Math, National Science Teachers Association, American Vocational Association, the list goes on and on.

So I think that we have hit upon a proper method. It is not locked in concrete. It is not a panacea as the Senator has mentioned, but it is something that hopefully by having and starting the hearings today, we have perhaps continued and highlighted the debate.

President Reagan said last night as he pulled out the newspaper and referred to the want ads, and the problem of unemployment that we need to train people for jobs.

Ladies and gentlemen, these bills relate to jobs, that is what we are talking about, j-o-b-s, and we cannot say it enough. It is not an immediate solution, but it is one that must be taken. And I again thank you for the opportunity to appear before the committee and again, urge your support for the legislation, but also ask you to allow me to work with you in your endeavors to meet this crisis.

Thank you.

[The prepared statement of Congressman McCurdy follows:]

PREPARED STATEMENT OF HON. DAVE McCURDY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OKLAHOMA

Mr. Chairman and Members of the Committee, I am pleased and honored to speak with you this morning about the national crisis in science and math education and the legislation that Senator Glenn and I have introduced (H.R. 6775) to combat the critical shortage of qualified math and science teachers. I want to commend you, Mr. Chairman, and the Education and Labor Committee, for devoting three days of hearings to an issue which affects every sector of society and threatens to erode our economic, scientific, and military leadership.

With the 25th Anniversary of Sputnik only days away, there is no more appropriate time to launch a new national initiative to improve science, math, and technical education. As a member of the Science and Technology and Armed Services Committees, I am concerned about the devastating implications scientific illiteracy has for our innovation, productivity and national defense. As a father and a private citizen, I am concerned that our children will grow up unprepared to participate in a technological world.

Last May I chaired a Science, Research and Technology Subcommittee field hearing on Pre-college Math and Science Education in Norman, Oklahoma. Again and again we heard: there are not enough math and science teachers and too many of those who are teaching are not qualified. Results of an Oklahoma State Department of Education state-wide survey were appalling:

1. 50 percent of Oklahoma science teachers are not qualifed.
2. In the fall semester of 1981, only 15 college students took the math or science teacher competency test, yet the State anticipates at least 250 vacancies in math and science teaching this year.
3. Over the last 10 years, there has been a 64 percent drop in the number of Oklahoma students completing mathematics teacher certification programs.
4. One superintendent said that three out of four of his science teachers are physical education instructors.
5. Another superintendent has 50 applications on file for a science teaching position, but none of the applicants is certified to teach science or math.
6. Still another superintendent conducted a three-state search for a well-qualified science teacher but was unable to find one.
7. Only 51 percent of Oklahoma students have taken geometry; 87 percent have never taken trigonometry; 96 percent have had no precalculus or calculus.

The problems of Oklahoma are severe, but no worse than in the other 49 states, and Oklahoma educators support the initiative which Senator Glenn and I have taken.

We all agree that something must be done to attract and retain qualified science and math teachers. I believe that a forgivable loan program will encourage more talented college students to pursue math and science teaching careers. This bill (H.R. 6775) is part of a broader initiative to address the present teacher shortage and ensure an adequate future supply of qualified science and math teachers. I know of at least two states, Alabama and the Chairman's home state, Kentucky, which have already taken action to attack the teacher shortage by enacting their own forgivable loan program for future math and science teachers. I commend these two states for their insight and commitment to improving math and science education and I hope that the federal government will soon follow suit.

Senator Glenn and I have also introduced H.R. 6774, the Math and Science Education Act, which grants tax credits to high tech firms that hire pre-college math and science teachers during the summer or allow their certified employees to teach math or science part-time in the local schools. These two tax credits would supplement teacher salaries and provide them with hands-on high technology experience to prepare their students for future jobs.

These bills are narrow in scope and cannot alone solve the national crisis in science, math, and technical education. I know that you, Mr. Chairman, and other Members, have introduced legislation that addresses other dimensions of the problem. H.R. 6774 and H.R. 6775 directly attack the teacher shortage and I believe they are an integral part of the solution. No matter how much time and money we invest in curriculum and equipment, if we don't have the qualified math and science teachers to prepare our young people for careers in science and technology, the trend toward scientific illiteracy will continue and we will surely surrender our position of world economic and military leadership.

Mr. Chairman, I appreciate having this opportunity to testify and I urge the Committee to support H.R. 6775. As a member of the Science and Technology and Armed Services Committees, I look forward to working with you to renew and strengthen our national commitment to excellence in science and math education.

Mr. SIMON [presiding]. We thank you very much for your testimony and for your leadership on this.

Let me touch on one aspect of your testimony, and that is on the military side. Back about a year ago, I inquired and I found out at that point, these figures are changed now, but at that point, we had 488,000 armed service personnel overseas, and of that number, 512 were regarded as linquistically competent in the language of the country where they were stationed.

I then had an amendment, you may recall, on the Department of Defense authorization bill to have the Defense Department look into what we ought to be doing and the initial reaction from some undersecretary somewhere was, we are fine, we do not have any problem.

I am pleased to say I got ahold of the Secretary of Defense and he quickly reversed that. But very shortly, we are going to hear from someone, Mr. Alvin Tucker, Director of Training and Education, from the Department of Defense, and let me quote what he has to say:

> At present, the military services are successfully recruiting sufficient numbers of young men and women with the requisite backgrounds in math, science and technical skills to fill entry-level positions in these occupations. Moreover, attrition in the training courses is at an acceptable level.

I gather you would disagree with that statement?

Mr. McCURDY. I would have to disagree, and again, to qualify, I do not know what entry-level positions he is addressing or speaking of, but General Marsh, the commander of the Air Force Systems Command testified before the Science Committee that in the Air Force, they are short literally thousands of engineers, and that they cannot perform their basic mission. Recently Secretary Weinberger testified and addressed the National Convocation of the National Academy of Sciences, and his quote, I have here because I saw it just this morning, was that we have to get people in this area, "Our youngsters need to be exposed as early as possible to science, math and technology.

"Unless we begin now to motivate and equip them to pursue scientific and technological careers, the shortages will persist."

The national lessons Sputnik taught us in 1957 still serve us. In recent statistics we received from a DOD report to the Armed Services Committee on the graduate engineering shortage, the military cannot afford to suffer a shortage of engineers because of its technological-intensive foundations, especially at a time when the United States will be short almost 80,000 engineers in the next few years. In 1982, the shortage of engineers: Air Force, 2,247; the Army, 2,670; Marines, 110; the Navy, 2,090.

As a member of the Armed Services Committee, and one who is a strong supporter of a strong national defense, I do not believe that the Army can become, or the military, the Department of Defense, can become the Department of Education for the United States.

And that is the direction that we are going in when we are talking about letting the Army have the incentive programs, letting them have the bonus programs. We need the bonuses and incentives to recruit and retain personnel, but they alone cannot do it, and that is why it is important that we get the private sector, the educational community and the Federal Government involved in what I believe to be a national crisis, and which I think people across the Nation are finally waking up to.

It is not as glamorous as sputnik, but the impact, I believe, is far greater.

Mr. SIMON. Just to confirm what you are saying, yesterday the subcommittee which Chairman Perkins chairs heard testimony that the military is reducing the grade level of the manuals from eighth-grade level to sixth-grade level.

Mr. McCURDY. Illiteracy is a problem. And I understand the chairman's leadership and I respect your leadership in the area of linguistics and the problem of languages and shortages in that area and the critical nature of that, and I agree that there is a problem. I am saying that we do not want to be competing in that area and unfortunately maybe because of scarce resources, it comes to that.

I respect your lead in that area, but I am saying that when we are talking about going home to the American public and selling to our constituencies what we are doing to improve and to address the critical jobs problem, the critical economic problems, I think the very foundation of our Nation, as Senator Glenn had mentioned, the very nature of our national foundation is education and providing everyone with the skills. I am always somewhat amazed when President Reagan refers to the quote of President Kennedy that the tide rises all ships, or ships rise with tide. That is what we are talking about in education; we want everyone to rise, not trickle down or whatever.

It is a question of the foundation and providing sufficient foundation for all to advance and have the opportunity, I think, to take us down that economic road.

Thank you.

Mr. SIMON. Thank you.

Mr. DENARDIS. Mr. Chairman, I just first want to applaud Congressman McCurdy for his initiative here. He presses it with eloquence and deep sincerity, it seems to me.

I would like to ask you, Dave, the current NDSL program does now have a loan cancellation provision for teachers to teach in certain elementary and secondary schools under the title I program.

In your research for the bill that you have presented, do you have any figures on the number of teachers who have, in fact, taken advantage of that provision and who have made career plans, career changes, as a result of knowledge of that provision?

Mr. MCCURDY. I don't have it available, but I would be glad to try to find that information and provide it for the record.

Mr. DENARDIS. I don't know the answer to it, either. My feeling is that it is not very significant and I do not mean to raise that to diminish your bill in any way, but simply to suggest that your bill in this area may not be enough to accomplish what I think we both want to accomplish.

Mr. SIMON. I would agree, and again, I welcome any comments and I think the gentleman knows that I am probably one of the most nonpartisan members of this body, and believe that we should be working together and have the cooperation of both sides of the aisle, because this is an American problem and I want to address it as such.

I would only ask perhaps for the enlightment of people here also, I am not sure anyone really believes that we should go out to the private sector alone. There are a few exceptional cases and we will have testimony on that today, but surely you are not contending that the Federal Government has no role whatsoever in this area.

Mr. Petri.

Mr. PETRI. I would join in thanking Representative McCurdy for being here for the bills.

One area that is kind of in your jurisdiction, I think, although it overlaps with the bill that you might be interested in, is that this Congress last session did adopt that same approach, the loan forgiveness in exchange for people serving in the Reserves or the Armed Forces, which has had a rather checkered implementation.

It was tried on an experimental basis and then stopped, and now, as of October 1, will be started again. But I had taken an interest in that particular thing and can tell you that the problem lies with what Representative DeNardis just said, that it is very difficult getting the word out.

What we have been trying to convince people in the Pentagon to do is just what every bank and financial institution does when it sends someone a bill; it includes a little notice talking about its other services and so on. When the people who take over these federally guaranteed student loans send someone a bill, we would like them to include a notice saying, if you are tired of paying this bill, call the following 800 number to get information about how it can be forgiven.

It does not cost any more in postage; it does not cost anything, and you get it precisely to the relevant market. And, in fact, the financial institutions have indicated they are very eager to do that because if they can get the Pentagon to pay these bills, it will save them collection costs and solve the problem, but the Pentagon has been dragging its feet because it seems like a lot of trouble, I guess, over there at a time when they have got surplus labor.

You are on the committee that maybe could hold their feet to the fire——

Mr. McCurdy. I think the point again that I made earlier, the Department of Defense is not designed, nor equipped, to be administering the educational functions. I mean, they are more concerned about other missions which they should be concerned about, and that is why I am saying that I do not think they should be moving in that direction.

Sometimes, believe me, in my work with them over there, they have enough bureaucratic problems of their own, and we are trying to steer through that mass and hopefully through the work of the Congress and the agencies that are currently in place, and again, relying as much as possible on the local agency, the school administrators, the counselors, et cetera, that are there for that function, that we can streamline and avoid much of the circuitous nature of DOD.

I might close with one point, too, being a member of the Science and Technology Committee, we have seen and had many a battle this year with the budget cuts for NSF, I mean, the National Science Foundation, and the areas there that many of you have been concerned about, but this legislation is something that you and I can take home and say, look, we are addressing a problem as it relates to jobs; we are not financing the study of the African black duck or whatever, you know.

Some of these studies and consulting things have gotten so far afield and you hear much about that and we have had them played back to us many a time, that we are saying this is something that everyone should and could relate to.

As you saw in my newsletter that I provided for you, you and I have a responsibility to inform the public of the nature of the problems and I think it is one function that you and I can perform.

Mr. Simon. We thank you very much for your testimony.

We now have a panel with Scott Thomson, Alvin Tucker, Elmer Boehm, Dr. Anne Flowers, and Dr. Paul Taylor.

We will hear from all witnesses before we have questions and if the witnesses care to insert their statements into the record, and summarize them, it does save some time. But you may proceed as you wish.

Mr. Scott Thomson, the executive director of the National Association of Secondary School Principals.

STATEMENT OF SCOTT D. THOMSON, EXECUTIVE DIRECTOR, NATIONAL ASSOCIATION OF SECONDARY SCHOOL PRINCIPALS

Mr. THOMSON. Mr. Chairman, I am coming here representing not only the National Association of Secondary School Principals today, but also representing in this testimony National Council of Teachers in Mathematics and the National Association of State Boards of Education.

I have submitted written testimony and I would just like to summarize a few points.

Mr. SIMON. Your written testimony will be entered into the record.

Mr. THOMSON. This morning, as we see the problem from the standpoint of the principalship or the teachers of math, for example, we see it being a multidimensional problem. It is an age problem, as Senator Glenn mentioned, and to hang some figures on the age problem, we know that the average age of the teaching force, secondary school level in the Nation is 36 years.

However, the average age of the science teachers across this country is 41 years. So we not only seem to be lacking seed corn, we seem to be lacking a few young plants along the way.

This is the first kind of dimension or element in this multidimensional problem. We have the problem of competency, the other element, preparation, again Senator Glenn mentioned that fact that in a survey of principals, high school principals, we found that 50 percent of our members of NASSP believe that the new science teachers that they employed this last year, 1981, were not qualified. That is to say that they were not majors in any of the fields of science or math.

We have a third dimension to the problem which is one of quantity. One dramatic statistic is that there are more school districts in the United States than there are physics teachers currently teaching at the secondary school level.

The problem, unfortunately, is going to get worse before it gets better. Our association currently is conducting a study of the changing admissions requirements for entrance to colleges and the State universities in the 50 States.

There is a dramatic story there that we are going to be reporting out in about 10 days. Excepting for a handful of States, the State universities systems have either increased the courses required for college admissions or have a study commission, a statewide study commission, looking at the problem.

And those States that have already increased their requirements for college admission, the pattern is very clear. They are adding a year of science, they are adding a year of math, first and foremost, along with requiring 4 years of English.

So what is going to happen regardless of the challenge from the Soviets or the Japanese, just if we are talking about admission to college, we are going to have a severe shortage tomorrow, 1982-83, this coming school year if these States do require double the number of math and science courses simply for college admission.

I happen to think it is a step in the right direction, but that is with us right now. It is not something that is 5 years away as far as a job.

I think a fourth dimension to the problem is what I call an inspiration gap. We are not only losing our younger teachers, they are not coming along, but perhaps we are not getting the quality that we should.

All of us know how important it is to have motivational, inspirational teachers. Particularly in the fields of science and math, and we must admit that sometimes these subjects can be dull.

Are we losing 10 percent of our potential science majors in college right in high school because of inadequate teaching, because of the subject being taught by minors in the field or people who are not properly qualified?

Louis Branscomb, who is chairman of the National Science Board, has pointed out that we compete very well in the international competition, international olympics, math olympics, that are held every year.

Normally the United States is first, second, or third. This last year, we were first. He points out, however, that our team members come from only five or six high schools traditionally.

What would it be like if we had 200 or 300 or 400 high schools providing a resource, providing the best in the way of trained high school students in math and science, we would be winning it every year.

So, we have that inspiration gap right now, and preparation gap.

A fifth dimension, and one that I am very concerned with as a citizen, is this whole matter of our limited futures that we are going to have as a nation if we are not adequately prepared with students in math and science.

It is not a matter of national pride, it is a matter of jobs, as we all know. The technical skills that come out of an adequate preparation in math and science actually provide the economic leverage, the central leverage point, that we have for improving our status, turning around the curve that is falling, since we do not seem to be able to compete as well in the areas of technology and science.

We cannot afford to be a handicapped nation when it comes to preparing our youngsters for math and science and for careers in the science and math field.

What can this bill do, just briefly? It is a start, but I would argue that it is a focus start, it is consciously a focus start as far as our associations are concerned.

It is not throwing money at problems, it is not a big chocolate chip cookie jar that everyone can reach in and fill himself. It may well be just a very few basic grains of granola to get at the problem and get it started, and to prevent the starvation that we seem to be encountering in the preparation of math and science teachers.

It is strategy 1-A, if you will, nothing fancy, and as far as we are concerned, we would certainly be supportive of modifications in additions to the bill.

But it does hit direct at the problem in three ways, and I will conclude with this summary.

It does provide an incentive for math and science majors to enter the teaching profession by the loan forgiveness program.

It does provide competitive wages, or can provide competitive wages, the tax and incentive program, offering teachers employment in the summer.

I would add that I don't think our problem is going to be losing teachers to the private sector in any great numbers if they can make a comparable wage. We do not have people leaving teaching in the math and science fields so much because they do not like the job, they are leaving because they cannot pay the bills.

And finally, it provides the element that every teacher needs, and that is in-service education, stimulation, modernization, opportunity to work in the private sector. So we certainly hope that you will consider the elements of this bill and will provide some support to it.

Thank you very much.

[The prepared statement of Scott Thomson follows:]

PREPARED STATEMENT OF SCOTT D. THOMSON, EXECUTIVE DIRECTOR, NATIONAL ASSOCIATION OF SECONDARY SCHOOL PRINCIPALS

My name is Scott Thomson. I am the Executive Director of the National Association of Secondary School Principals, the largest school administrator organization in the nation, representing some 34,000 school site administrators. I am pleased to testify before you today on behalf of NASSP and a number of our sister associations who share our concern about the declining state of math and science instruction at all levels of our education process. These include the National Council of Teachers of Mathematics and the National Association of State Boards of Education. I speak for all of these organizations when I say that we as a nation are facing a critical period in our industrial-technological history, and we can survive this period only with a major national effort spearheaded by federal leadership. Over the past decade we have witnessed a sharp and extended decline in our country's capacity to effectively compete with our industrial competitors in the area of high technology. America's long held preeminence in such areas as petroleum technology, nuclear physics, chemical and metallurgical engineering, and computer and electronic technology is waning.

The crisis is severe enough, as we see it, that the nation's economy and national security is, or soon will be, compromised. Reversal of this ominous trend must begin now, and must be triggered by a federal commitment which is based on investment in our greatest national resource-our human capital.

The solutions to our returning as the world's leader in technology are indeed multifaceted. They rest on new and innovative research, higher industrial productivity, creative uses of robotics, and innovative uses of computer hardware and software. But we contend that the roots of all of these advancements continue to lie in our educational institutions, particularly at the elementary and secondary level. The reversal of these trends will require greater numbers of students to pursue engineering degrees, and schools prepared to deliver stronger math, science and comptuer instruction.

Before I expand on our focused solution to this problem, it would be useful for us to explore some of the hard statistics which I believe will make the need for action even more apparent. The United States now lags behind Japan, West Germany, Eastern Europe, and Russia in the number of engineers and scientists graduated from their higher education institutions. For example, Japan in 1979 produced some 22,000 electrical engineers, while the United States produced 16,000. Only a decade earlier, Japan had produced only 12,000 electrical engineers, while the United States produced slightly more than 16,000. While our demand for more "hard sciences" graduates has increased, we have produced fewer of them. The American

Electronics Institute suggests that U.S. colleges and universities in 1981 prepared only 43 percent of the demand for new graduates in the electronics-related industries.

To add dimension to what we believe is a growing national crisis, the Carnegie Foundation for the Advancement of Teaching found that in 1969 the percentage of higher education faculty teaching math or the physical sciences was 14 percent. By 1975 that figure had dropped to seven percent, and the enrollments in these areas showed similar decline. I would add that all other fields, including the humanities, social sciences, the arts, and the professions held steady their percentage of faculty teaching those areas.

The crisis not only lies in our higher education institutions, however. Our elementary and secondary schools are experiencing similar problems. Our colleagues in the National Science Teachers Association and the National Council of Teachers of Mathematics have found in their studies that our elementary and secondary schools have experienced over the past decade a 77 percent decline in the number of secondary level math teachers prepared and a 65 percent decline in the number of math teachers prepared to teach in secondary schools. This alarming decline had led to understaffing of our math and science classrooms in many of our elementary and secondary schools. The National Center for Education Statistics in a 1981 survey found nation-wide that there are 8.3 percent fewer math teachers and 5.5 percent fewer physical science teachers that are needed in our schools. The national study of estimated supply and demand of secondary school science and math teachers indicates that 43 of 45 states responding had a shortage or critical shortage of math and science teachers.

Meanwhile, the number of under-qualified or unqualified teachers in these classes continues to grow dramatically. A survey of principals, also conducted by the National Science Teachers Association, indicated that 50 percent of the newly employed math and science teachers were judged by their principals to be "unqualified" but were employed on an emergency basis.

These statistics reveal a fundamental weakness in our educational system. Our math and science teachers are leaving our schools in droves for more financially lucrative industry jobs. As we become more and more a high technology society, the demand for workers with skills in math and science increases. With an insufficient number of new graduates holding degrees in math and science joining the pool of available workers, our schools have become an obvious recruiting ground for local and regional industries. Our school districts cannot compete with the private sector which pays between 50 and 70 percent higher wages.

Of course, the long-term implications of this talent drain from our schools is most discouraging. It is at the elementary and secondary levels of a youth's education that both competence and academic self-image take root. We need highly qualified teachers who can turn our students on to the hard sciences. These students can then pursue their physics, chemistry, math and computer sciences curricula in college, thus filling the growing demand for science, math and computer-related jobs in the private sector.

We must simultaneoously find ways of placing a higher priority on the teaching profession which will narrow the tremendous wage gap that currently exists between teaching and comparably demanding industry jobs.

Together with addressing this wage differential, we must give close attention to the information gap which exists between the classroom and the industrial workplace. Teachers of math and science need opportunities to upgrade their understanding of the rapidly changing technologies and their use in industry. Without these opportunities, the dynamics of our rapidly changing high tech society will leave our elementary and secondary classrooms in the dark. Opportunities for inservice and additional course work at universities will help teachers strengthen their math and science course offerings, but more must be done. Stronger linkages must be developed between schools and industry so that our teachers can have hands-on experiences with the latest applied technologies currently in use. The resources of industry must be tapped to serve the growing needs of schools and the long-range needs of our information society.

Industry can help schools by sharing with the schools those former teachers who have left the schools over the last several years. Our schools' short-term needs for qualified and informed math and science teachers can be served with greater cooperation between our schools and industry.

As I have mentioned before, the problem as I have described above will require a wide range of action from federal initiative right on down to the everyday classroom activities. We, of course, look to both of these distinguished Subcommittees for leadership in addressing this multifaceted problem. We, as you know, have been working very closely with Congressman McCurdy and Senator Glenn on two bills, H.R. 6775 and H.R. 3774, which we believe address the roots of this crisis, that is, infusing new graduates into our math and science classrooms by providing low cost loans to college students pursuing math and science degrees with the provision that the loan would be forgiven on the basis of 25 percent per year for teaching in an elementary or secondary school. We have no illusion that such a loan program will immediately incite new majors in math and science on our universities, but we do recongize that students develop interests in particular fields over a long period of time, particularly in the areas of math and science which are quite clearly cumulative in nature. That is, a student doesn't decide to pursue engineering in the senior year of high school, after having taken only a general science or biology class. We do expect that this loan program will provide sufficient incentive to those who receive loans to stop by the school house for at least a couple of years, if not four years, on their way to more lucrative industrial positions. We could make great strides in strengthening our curriculum if these graduates serve only a few years in our elementary and secondary schools.

The loan program would help narrow the industry-school gap by forgiving as much as $2,500 to $3,000 of a loan per year.

The McCurdy-Glenn legislation also places great emphasis on tapping the resources available in business and industry. Through the tax code, businesses would be given tax breaks for hiring math and science teachers over the summer months in high technology jobs. Teachers, in this way could learn the latest applied uses of technology in such diverse industries as computers, petro-chemicals, word processing, electronics or agricultural technology to name just a few. Aside from this professional enlightenment, the supplemental wages earned over the summer will place teacher in a competitive income bracket so the likelihood of their leaving the school for purely financial considerations would be lessened.

Another aspect of the McCurdy/Glenn legislation directly addresses the short-term immediate need for more qualified teachers in our schools. As I mentioned earlier, we have witnessed a mass exodus of our teachers fleeing to higher paying industry jobs over this past decade. Using the tax code once again, we propose providing tax incentives to industry to share their employees who hold teaching certificates with the schools on a part-time basis. This would require little or no bureaucracy, just some negotiation between school districts and their local industries. The benefits would be great. Aside from filling a chemistry II or physics or calculus class with a qualified, experienced instructor for perhaps ten hours a week, we envision schools taking advantage of this increased cooperation with industry in a number of ways. The cumulative interaction between school administrators and industry officials would be unleashed to the benefit of the students.

As I mentioned at the outset, the solutions to turning around America's technology decline are many, and no one institution nor one level of government can do it alone. We hope that the McCurdy/Glenn concepts can be incorporated in a broad piece of legislation designed to address this national crisis.

I thank the Subcommittee for the opportunity to share our views about how our schools can contribute to solving this national crises, and pledge our assistance to both of these distinguished committees as you move to fashion a politically and economically feasible solution. Thank you.

I would be pleased to answer any of your questions.

Mr. SIMON. Thank you very much, Mr. Thomsom.

Mr. Alvin Tucker, Director of Training and Education, Assistant Secretary for Defense, Manpower, Reserve Affairs, and Logistics with the Defense Department.

STATEMENT OF ALVIN TUCKER, DIRECTOR, TRAINING AND EDUCATION, ASSISTANT SECRETARY FOR DEFENSE (MANPOWER, RESERVE AFFAIRS, AND LOGISTICS), U.S. DEPARTMENT OF DEFENSE

Mr. TUCKER. Thank you, sir. You have my statement and I would like to submit it for the record.

Mr. SIMON. It will be entered in the record.

Mr. TUCKER. I might make a few comments.

The statement I prepared, sir, deals with enlisted force. The question that Representative McCurdy raised concerning graduate engineers or engineers, deals with the officer force. I did not know that that would be a subject this morning, but I have brought with me a copy of the report that was prepared in my office concerning the shortage of engineers and graduate engineers in the military department.

I would like to submit that for the committee's consideration.

As my report says, or my statement says, we are doing quite well now in recruiting the people we need. The Department of Defense appreciates the problems in math and science within the country. We are taking those steps that are necessary and that are within our power to correct the situation with regard to the Armed Forces so that we can keep our national defense strong.

We do have fears for the future. Mr. McCurdy was absolutely correct in quoting Secretary Weinberger's concern about math and science. Also, you know, he is concerned about foreign language training.

I would just conclude my remarks by saying that in the same conference that Secretary Weinberger spoke, President Reagan said:

> In the final analysis, it will take a wide range of institutions, with the support of the American people, which will bring about the progress all of us seek in improving precollege mathematics and science education.

The answer lies in imaginative initiatives undertaken to bring together all levels of the private and public sectors to achieve the goal we all share.

Thank you.

[The prepared statement of Alvin Tucker follows:]

PREPARED STATEMENT OF ALVIN TUCKER, DIRECTOR OF TRAINING AND EDUCATION, OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS AND LOGISTICS), U.S. DEPARTMENT OF DEFENSE

Mr. Chairman and Members of the Subcommittee

I appreciate the opportunity to discuss with you this morning the needs of the armed forces for persons with backgrounds in mathematics and science and for persons with technical skills.

The military tests the ability levels of applicants for enlistment through the use of the Armed Services Vocational Aptitude Battery (ASVAB). The ASVAB consists of the 10 subtests shown in Table 1.

Table 1
ASVAB Subtests
(Forms 8, 9, and 10)

- Arithmetic Reasoning
- Numerical Operations
- Paragraph Comprehension
- Word Knowledge
- Coding Speed
- General Science
- Mathematics Knowledge
- Electronics Information
- Mechanical Comprehension
- Automotive-Shop Information

These subtests are included in the battery because research and experience show they are valid predictors of success in various types of military job training. The scores of four of the sub-tests (word knowledge, paragraph comprehension, arithmetic reasoning, and numerical operations) are combined to produce an Armed Forces Qualification Test (AFQT) score. DoD uses the AFQT as a general index of trainability. These AFQT scores have been referenced statistically to the extensive testing of officers and enlisted men that took place during World War II. For more than 35 years this World War II reference population has been the baseline for comparing aptitudes of military recruits.

For reporting purposes, AFQT scores have been traditionally grouped into five categories based on percentile score ranges on the test, as shown in Table 2.

Table 2
AFQT Categories by
Corresponding Percentile Score Range and
Distribution of World War II Reference Population

AFQT Category	Percentile Score Range	World War II Reference Population Distribution (Percent)
I	93 - 100	8
II	65 - 92	28
III	31 - 64	34
IV	10 - 30	21
V	1 - 9	9
		100

People who score in Categories I and II tend to be above average in trainability; those in Category III are average; those in Category IV are below average; and those in Category V are markedly below average and, under current Service policy, are not eligible to enlist.

To avoid misunderstandings, I would like to point out that in percentile terms a score of 50 is average; it is not a low score. It means a person's raw score on the test falls at the mid-point of the range of all scores.

Our current data on the aptitude levels of recent recruits show that Defense is doing well in recruiting people with the skills needed by the military. In both FY 1981 and FY 1982, thru June, more than 80 percent of new recruits scored average or above on the AFQT (Categories I thru III), as shown in Table 3.

Table 3
AFQT Categories I Thru III
Percentage of Non-Prior Service Accessions

Service	FY 1981	FY 1982 (Thru June)
Army	69	81
Navy	88	90
Marine Corps	87	92
Air Force	93	94
DOD TOTAL	82	88

Also, over 80 percent were high school diploma graduates, as shown in Table 4.

Table 4
High School Diploma Graduates
Percentage of Non-Prior Service Accessions

Service	FY 1981	FY 1982 (Thru June)
Army	80	82
Navy	76	74
Marine Corps	80	79
Air Force	88	93
DOD TOTAL	81	82

In terms of percentile scores on the AFQT, our data show that there has been a significant increase in the ability levels of new recruits; in fact, so far in FY 1982 thru June, all the Services have been attracting better than average people, as shown in Table 5.

Table 5
Average AFQT Percentile Scores
Non-Prior Service Accessions

	Army	Navy	Marine Corps	Total Air Force	DoD
FY 1982*	54	63	62	70	61

*Thru June 1982

As I said before, our AFQT percentile scores are calibrated against a World War II reference population. In order to determine how the Department was doing in relation to the current youth population, DoD contracted with the National Opinion Research Center of the University of Chicago to administer the ASVAB to a representative sample of American young people during the Summer of 1980. We then compared the test results with the 1944 reference population and with the test scores of current entrants into the military. The results of the study entitled "Profile of American Youth," were published in March 1982. I have provided the Subcommittee with a copy of this report.

In general, the report shows that the distribution of the AFQT scores for the current youth population compares favorably with the World War II reference population, as shown in Table 6.

Table 6
AFQT Distributions of 1980 Male
Youth Population and World War II Reference Population [a]
(Percent)

	AFQT Category						
	I	II	III	IV	V	Total	Median
1980 Male Youth[b]	5	35	29	23	8	100	53
World War II Reference	8	28	34	21	9	100	50

[a] 1980 Male Youth Population is restricted to persons born between January 1, 1957 and December 31, 1962 (18 through 23 years at time of testing, July-October 1980).

[b] Females are excluded from this table because the World War II reference population was exclusively male.

The profile also shows that in FY 1981 DoD recruited people who were a cut above average when compared to contemporary youth, as shown in Table 7.

A comparison of recent data with the results of the profile indicates that the Services are also attracting people in FY 1982 with verbal and math skills that are slightly above average. These data are shown in Table 8.

Table 7

Distribution of 1980 Youth Population and FY 1981 Nonprior Service Accessions by Armed Forces Qualification Test (AFQT) Category and Sex[a]

	AFQT Category[b]							
Sex and Population Group	I	II	III	IV	V	Total	Median	Percent Scoring AFQT 50 or Above
	(Percent)							
Male								
FY 1981 Accessions								
Army	2	21	43	34	0	100	41	39
Navy	3	35	48	14	0	100	56	60
Marine Corps	3	29	53	15	0	100	52	54
Air Force	3	39	50	8	0	100	59	67
Total DoD	3	30	47	20	0	100	52	54
1980 Youth	5	35	29	23	8	100	53	54
Female[c]								
FY 1981 Accessions								
Army	2	19	47	32	0	100	42	37
Navy	3	34	54	9	0	100	57	62
Marine Corps	3	47	50	d	0	100	64	82
Air Force	3	39	54	4	0	100	59	70
Total DoD	3	29	51	17	0	100	53	55
1980 Youth	4	31	34	25	6	100	50	51
Total								
FY 1981 Accessions								
Army	2	21	43	34	0	100	41	39
Navy	3	35	48	14	0	100	56	61
Marine Corps	3	30	53	14	0	100	54	57
Air Force	3	39	50	8	0	100	59	67
Total DoD	3	30	47	20	0	100	52	54
1980 Youth	4	33	32	24	7	100	51	53

[a] 1980 youth population and FY 1981 nonprior service accessions restricted to persons born betweeen January 1, 1957 and December 31, 1962 (18 through 23 years).

[b] Persons scoring in AFQT Category V are not eligible for military enlistment.

[c] Females comprise approximately one-half of the 1980 youth population and less than one-fifth of FY 1981 accessions.

[d] Less than 0.5 percent.

Table 8
Average Verbal and Math Percentile Scores Derived from the AFQT
Non-Prior Service Accessions

Accessions	Verbal	Math
FY 1981	51	51
FY 1982	52	53
1980 Youth Profile	51	50

Mr. Chairman, I recognize that the subcommittee is also interested in knowing how many people the military needs with specific backgrounds in math, science and technical skills. In this regard there are two categories of requirements - mandatory and desirable.

There are currently almost 50,000 jobs within the Armed Forces that require applicants who have had specific math or science education, usually courses taken in high school, to be eligible for training and subsequent assignment in these occupations. Table 9 summarizes these data by Service.

Table 9
Mandatory Math or Science Background Required to be Eligible for Training

	No. of Occupations	No. of Enlisted Positions	Percent of Enlisted Force
Army	57	35,947	6.2
Navy	3	12,000	2.0
Air Force	6	1,689	*

*Less than one Percent

These occupations include satellite communication equipment repairer in the Army; nuclear power technicians in the Navy; and engineering assistant in the Air Force. The specific requirements differ with each occupation but in general include such things as courses in algebra, or physics, or chemistry.

While the occupations with mandatory backgrounds in math and science are only a small percentage of the total force, the occupations in which a technical background prior to training is desirable makes up a much larger percentage of the enlisted force. As Table 10 shows, there are over 715,000 such jobs in the military.

Table 10
Desirable Background in Math, Science
and Technical Skills Desirable

	No. of Occupations	No. of Enlisted Positions	Percent of Enlisted Force
Army	188	130,696	22%
Navy	37	271,420	45%
Air Force	183	313,147	72%

Although applicants for these jobs need not have taken formal math and science courses in high school, they must show an aptitude for these occupations by scoring well on particular subtests of the ASVAB, such as general science, mathematics knowledge, electronics information, mechanical comprehension, and automotive-shop information. The specific scores required vary with the occupation and are based on the past experience of the Services in successfully training people into these jobs.

At present, the Military Services are successfully recruiting sufficient numbers of young men and women with the requisite backgrounds in math, science, and technical skills to fill entry level positions in these occupations; moreover, attrition in the training courses is at an acceptable level. In the past, however, the Services have had difficulty retaining experienced NCOes with the technical skills that were in high demand in the private sector. Fortunately, this drain of experienced personnel has recently abated as shown by the reenlistment statistics in Table 11.

Table 11
Reenlistment Summary
(Percent of Eligibles)

	First-Termers		Career Force	
	FY 1981	FY 1982 (Thru June)	FY 1981	FY 1982 (Thru June)
Army	55	66	73	86
Navy	42	56	73	81
Marine Corps	27	40	74	78
Air Force	43	58	86	90
Total DoD	43	58	77	85

Our current success in both recruiting and in retention is due in large part to the actions taken by this Congress to restore military pay to competitive levels. While the current rate of national unemployment is certainly a factor, I do not believe we can discount the importance of adequate pay, enlistment and reenlistment bonuses, educational incentives, a more effective advertising campaign, and a new enhanced sense of patriotism among young people in reversing the difficult recruiting environment we faced in the late 1970's.

As to the future, Mr. Chairman, the Services anticipate a growth in their requirements for servicemembers with math, science, and technical skills. The Air Force forecasts a 33 percent increase in their requirements for people with mechanical and electronic aptitudes by the year 2000. The Army due to its on-going modernization program has already experienced an increase of 34 percent in technical skill requirements between 1980 and 1982. As the Army continues its equipment modernization program, continuing growth in these requirements is expected. The Navy also anticipates a 16 to 17 percent growth in its requirements for people with math, science and technical skills by 1987.

Certainly a future decline in the number of persons with adequate backgrounds or abilities in mathematics, science and technical skills could hamper Defense efforts if, as a result, DoD were unable to attract a sufficient number of qualified personnel to meet manpower needs. However, the Department feels that certain actions could offset this decline.

First, we must maintain pay scales for our military personnel that are competitive with the civilian sector. This will allow us to attract good young recruits and to retain experienced technicians. Second, we must maintain our package of enlistment and reenlistment bonuses at a level sufficient to attract people to specific critical occupations. Third, we must retain educational incentives, such as the Army College Fund, that directly appeal to persons with better educational backgrounds.

Finally, we must use technology to make our equipment easier to operate and maintain. This does not mean developing less sophisticated, less capable equipment; it means that the interaction between the equipment and the operator, or maintainer, must be simplified. An example of this simplification is the M-1 Abrams Tank. While the Abrams is more capable and more sophisticated, it is also easier to drive and shoot than any previous tank.

Mr. Chairman, the Department of Defense recognizes the importance of math, science and technical skills in maintaining the productivity and strength of the nation. These same skills are essential for a well trained and well prepared military force. We in Defense note with satisfaction that the recent results of the Scholastic Apptitude Test indicate a reversal of the past trend toward declining math and verbal skills. This reversal, I know, results from the dedicated efforts of educators throughout the country who have worked to revise curricula and raise educational standards. The future, of course, is uncertain but we hope that the continuing efforts of the educational community will result in an adequate number of well prepared young men and women for all segments of American society.

Mr. SIMON. We thank you, Mr. Tucker.

Mr. Elmer Boehm, the manager for engineering of Monsanto Co., and if I can just add, Mr. Boehm, the Monsanto plant in Illinois has just been added to my district, and I had a fine tour given to me by Jack Malloy and the others over there a few weeks ago.

Pleased to have you here, Mr. Boehm.

STATEMENT OF ELMER BOEHM, MANAGER, ENGINEERING, MONSANTO CO.

Mr. BOEHM. Thank you. I worked in that plant for about 6 years, so I appreciate that area.

I think my testimony has been entered into the record.

Mr. SIMON. It will be entered into the record.

Mr. BOEHM. We participate in a rather innovative way in the area of math and science encouragement. In the St. Louis area, we have a school partnership program, and I might mention, Mr. Andrews, that in Wilmington, N.C., they have a similar school partnership program like this and it is quite active. I am sure he is aware of this.

The Monsanto Co. has participated in the voluntary, and it is voluntary, Southwest High School partnership program. Mainly because of our social responsibility to the community, and second, our need for strong secondary education programs, particularly in the area of math and sciences.

We now have been involved with this particular high school for 3 years and we have, Monsanto has, 80 people, engineers, scientists, technicians, working with the teachers and the students at this high school.

The program, when it was started 3 years ago, had 8 subjects, such as chemistry, physics, math, and there are now 14 subjects, which included the areas of biology and computers.

The program involves 10 to 15 teachers and 400 to 500 students at this particular school. The entire partnership program in the St. Louis area involves 12,000 students, but it involves all aspects of teaching, not just science and math.

During the past year, Monsanto has contributed 1,200 manhours, in terms of people's time, by the Monsanto volunteers, which is primarily done during their office hours in teaching at the school or having the students come out to the offices, assisting them in that area.

In addition, the program has created an improved relationship between the superintendent of schools, the principals, the teachers, and the students.

When we initiated this program, we conducted an orientation session for the Monsanto volunteers and the Southwest High teachers.

At that time, the physics teacher, Mr. Ron Zopf, made three points.

One, he did not want the volunteers to teach his course; he felt that that was his responsibility, and he had some intrepidations about it at the time

Second, he did want the enrichment of the course that the volunteers could provide, and third, that the role of engineers and scientists from Monsanto would provide inspiration and career guidance for these people.

And incidentally, four of our volunteers are graduates of that particular high school, so these young people see that there are opportunities for them in the science and math fields.

The teachers have been very supportive of the program and look forward to each year of additional programs, they are learning a lot, it is enhancing their program, and in addition, they have an opportunity to explore new areas in the technical world.

We have geared the program to provide career guidance for potential college students and potential junior college students, and for high school graduates, because many of these technical programs only require a high school degree.

At the end of each year, Mr. Marvin Koenig, the principal of Southwest High School, invites all of us, the volunteers, to have lunch with him and the teachers at the high school cafeteria.

At that time, each student presents to the volunteer a paper certificate thanking them for their services, and that is the only reward we get, well attended. They call it the Marvin Award, after Marvin Koenig.

It also provides some self-confidence for the students because they must get up and make these presentations individually, and for a high school student, that is a difficult task to do in front of 100 people.

In my conversation with Mr. Koenig, he noted a concern about his science teachers who were approaching retirement age. As Mr. Thomson said, they are older than the run-of-the-mill teachers. And he has no potential teachers to replace them.

So, he is concerned about this circumstance, but not only the future of math and science teachers in jeopardy, but the future of engineers and scientists for industry are in jeopardy.

The Monsanto Southwest High School partnership program is one of the many in the St. Louis area that is designed to provide career guidance for the high school students, whether it be for further education or direct entry into the marketplace.

However, if there is an interest on the part of the student for further education, the program provides encouragement for he or she to enter the science field.

In general, industry provides higher salaries than the teaching profession. Therefore, there needs to be some incentives for graduates to enter the teaching field.

There are many graduates who would prefer teaching professions to working in industry.

Thank you.

[The prepared statement of Elmer Boehm follows:]

Prepared Statement of Elmer Boehm, Manager of Engineering, Monsanto Co.

Monsanto has participated in the voluntary Southwest High School partnership program because of our social responsibility to the community and because we recognized the need for a strong secondary education program, particularly in math and the sciences.

We now have been involved with Southwest High School for three years and have about 80 volunteers. The program has expanded from eight school subjects to 14 subjects—such as chemistry, physics, math, computers, biology, office machines and study skills. The program involves 10-15 teachers and 400-500 students. During the past year 1,200 hours were contributed by the Monsanto volunteers, which is primarily done during regular office hours. In addition, the program has created an improved relationship between the superintendent of schools, the principals, the teachers and the students.

When we initiated this program we conducted an orientation session for the Monsanto volunteers and the Southwest High School teachers. At that time the physics teacher, Mr. Ron Zopf, made three points: (1) he did not want the volunteers to teach his course, this was his responsibility, (2) he did want the enrichment to the course that the volunteers could provide, and (3) that the role of engineers and scientists from Monsanto would provide inspiration and career guidance. Incidentally, four (4) of our volunteers were graduates of this high school.

The teachers have been very supportive of the program and look forward to each new year and additional special programs for the students and, in addition, opportunities to explore new areas of the technical world. We have geared the program to provide career guidance for potential college students and potential junior college students, and opportunities for high school graduates.

At the end of each year Mr. Marvin Koenig, the principal, invites all the volunteers to have lunch with the teachers and students in their school cafeteria. At that time the students present a certificate to each of the volunteers—this is called the Marvin Award. It also provides some self-confidence for the students.

In my conversation with Mr. Koenig, he noted a concern about his science teachers, who were approaching retirement age, as he had no potential teachers to replace them. We too are concerned about this circumstance because not only is the future of science and math teachers in jeopardy, but the future of engineers and scientists for industry is in jeopardy.

The Monsanto Southwest High School partnership program is one of many in the St. Louis area that is designed to provide career guidance for the high school student, whether it be for further education or directly entering the work place. However, if there is an interest on the part of the students for further education, the program provides encouragement for he or she to enter the science field. In general, industry provides higher salaries than the teaching profession, therefore, there needs to be some incentives for graduates to enter the teaching field. There are many graduates who would prefer the teaching profession to working in industry.

I am a native of Ohio, born and raised in Cincinnati. I graduated from the University of Cincinnati with a degree in chemical engineering. It was my high school chemistry teacher who encouraged me to consider the science field. Perhaps it was his concern for me and his ability to make science interesting that prompted me to become involved in the St. Louis public school partnership program, for which I have been responsible over the past three years. This is a part of Monsanto's volunteer program.

Monsanto has $6 billion sales and has about 50,000 employees worldwide. St. Louis is our world headquarters and we have about 10,000 employees in the St. Louis area. We have called upon these St. Louis resources to participate in the partnership program.

The St. Louis public schools have a partnership office headed by Mr. Wayne Walker as part of their administrative staff. They have partnership programs with many firms and institutions in the St. Louis area such as McDonnell Douglas, Ralston Purina, Missouri botanical gardens, Peabody Coal and many others.

Mrs. Helen Lynch has been the public school partnership coordinator between Southwest High School and Monsanto. At our first session she presented a number of requests for assistance from Monsanto. These included specific needs developed by the respective teachers for course enrichment and the need for volunteers to assist in these enrichment needs.

Based on these needs I initiated support from Mr. Al Andrews, vice-president of engineering, and proceed to obtain volunteers. The first year was of an experimental nature for both the teachers and the Monsanto volunteers. The primary source of volunteers was our engineering department and involved participation in chemistry, physics and math. As the program has matured, we have expanded our resources to the research department, secretaries, technicians and business personnel.

We now have research scientists and technicians assisting in such courses as: General chemistry; consumer chemistry; advanced chemistry; polymer chemistry; physics; and biology.

We have also involved our engineering graduates and computer technicians in such subjects as: General math; algerbraic functions; fortran writing; and computer hardware.

And have involved our business and secretarial personnel in: Accounting; office machines; typing; secretarial services.

The volunteers include many female and minority employees. Each of our volunteers works directly with their respective teachers in developing a program that meets the teachers' needs of program enrichment. This includes sessions on the school site at which time the Monsanto volunteer may present a practical application of one of the principles being taught by the teacher. Or it may be a tour of one of our facilities which may provide some career guidance for the students. And in many cases we provide "hands-on" experience with computers, instrumentation, word processors and research equipment.

After the first year of involvement, Mrs. Lynch conducted an evaluation of the program. At this time it became obvious from the Monsanto volunteer participants that there was a need to improve the study habits of the students. As a result, principal Marvin Koenig initiated a study skills program for all grades for the following school year. The Monsanto people also participated in this study skills program, which has been expanded to a broader approach of character building, self-confidence and writing skills.

A good example of self-confidence was demonstrated when one young man who was unable to stand up and speak in his classroom was coached during the year in his study skills course. When the school had its annual awards program for the Monsanto volunteers (this is called the Marvin award), his responsibility was to present the award to his coaches. It was a difficult moment for him and a tense situation for an audience of more than 100 people; however, when he finished there was a resounding applause. This is just one of the many examples that has made the program a great success.

Additional results of the evaluation by the students: High regard for sponsoring organization individual participants. Sponsors genuinely cared about students. Programs presented at student level. Improved their outlook for job opportunities. Sponsors made a contribution to the community. Broader and more thorough understanding of Monsanto. Understanding better our cost to do business. Monsanto is concerned about people. A better understanding of the technical profession.

By the teachers: Positive reinforcement for their courses. Benefited personally from the sponsors' reinforcement. Realistic and practical approach to the subject. Person-to-person contact with successful individuals (4 of our people graduated from S.W.H.S.). Many of the comments by the students about Monsanto were also related by the teachers and administrators.

By the Monsanto volunteers: There was an improved attitudinal change of students, teachers and the school administration. Improved courtesy, attentiveness and dress of the students. They had to review many of their basic technical concepts. Offered career guidance. Worthwhile experience.

Because of the enthusiasm for the program, a professional educational filming was made by T. Iglehart for future viewing on the educational TV channel in St. Louis.

In order to guarantee the future of America's technology, it is imperative that we support and foster the education of teachers in math and the sciences.

SOUTHWEST HIGH SCHOOL,
OFFICE OF THE PRINCIPAL,
St. Louis, Mo., September 24, 1982.

Mr. ELMER L. BOEHM,
Manager, Engineering—CS6F,
Monsanto Co., St. Louis, Mo.

DEAR MR. BOEHM: We are extremely pleased that the Monsanto Co. will be working with Southwest High School in the Partnership Program for 1982-1983. Our past two school years have been greatly enriched by our involvement with the men and women of your company.

Both students and teachers feel that Monsanto's work with us has been invaluable. Not only has the involvement of your company served as a motivation factor for many of our youth who are groping for a perspective in life, but the technical assistance given to the classes has been an extra that our faculty would not have been able to provide.

We look forward to meeting with your personnel on October 27, 1982. The teachers in the following subject areas will be present: accounting, biology, chemistry, computers, mathematics, physics, secretarial and study skills. With our shortage of qualified teachers and large classes, it is most important to have you working with us again this year.

Sincerely,

Marvin O. Koenig, *Principal.*

Mr. **Simon**. Thank you very much, Mr. Boehm.

Dr. Anne Flowers, the dean of the School of Education, Georgia Southern College.

Dr. Flowers.

STATEMENT OF ANNE FLOWERS, DEAN, SCHOOL OF EDUCATION, GEORGIA SOUTHERN COLLEGE

Dr. **Flowers**. I am pleased to have an opportunity to testify before this group today. I have submitted written testimony which I would like to have entered into the record.

Mr. **Simon**. It will be entered in the record.

Dr. **Flowers**. I will summarize that statement now.

I am also president-elect of the American Association of Colleges for Teacher Education. AACTE is a national professional organization of colleges and universities dedicated to teacher preparation and renewal.

Collectively, our member institutions prepare over 80 percent of all the new teachers annually.

I have been invited to discuss the nature of shortages of mathematics and science teachers and from the perspective of higher education how some of those problems can be addressed.

First, let me assure you, the shortage of qualified teachers is real and it is a problem likely to grow during the coming decade.

Between 1971 and 1980, the annual number of new teacher graduates decreased 50 percent. In 1981, 43 States reported a shortage of qualified mathematics teachers and between 1970 and 1980, there was a 77-percent decline nationwide in the number of secondary school mathematics and science teachers being trained.

Only 600, or 40 percent of the Nation's teacher preparation institutions currently graduate math teachers, and only 55 percent of those graduates enter teaching.

In my own State of Georgia, 70 prospective mathematics teachers were graduated from our colleges and universities last year. Of these, only 60 percent of them went to the classroom.

The dropout rate for the first year was 35 percent, with a projected loss of 10 percent each year hereafter. Many of our new teachers come to Georgia from the Midwest, from Michigan, Indiana, Illinois, and Minnesota.

This year we will have mathematics in our State, but it will be at the expense of some of our neighbors to the north.

In 1981, nationwide, almost five times more science and mathematics teachers left to take nonteaching jobs than teachers in other disciplines. The replacements for these trained teachers are often inadequately prepared.

Of the teachers newly employed in 1981-82 to teach high school mathematics or science, 50 percent are teaching with emergency certificates.

An undersupply of mathematics and science teachers is part of an overall teacher shortage. Georgia was able to find some people to fit into the classroom at the expense of other States.

Our concern remains in all areas, as well as in the mathematics and science undersupplies. The latest vacancy survey for our teaching positions in Georgia, completed just last week, indicated that we are suffering shortages in eight other areas, and Georgia's shortages are not unique.

Clearly, solutions limited to one discipline will not be much consolation to school districts experiencing shortages in other disciplines.

A number of solutions have been proposed for the mathematics and science teacher shortage; many are excellent; none should be considered as an exclusive remedy.

Several of the proposals will address the teacher shortage issue in the long run, while others may have a more immediate impact. All of these need to be reviewed and considered within the large context of insuring competence and excellence of teachers.

We hope that Congress would address the need for a comprehensive education personnel development policy, which would insure the preparation of sufficient numbers of qualified teachers to meet current and future demand.

I would caution you to beware of simplistic solutions, which address only a small component of the problem, or create greater problems.

Certification waivers are one such issue. An emergency or provisional certificate in an inappropriate response to the shortage problem. Knowledge of subject matter alone is not sufficient preparation for teaching it.

Bright, caring, intelligent arts and science graduates are available, but are they qualified? Do they know about sequencing of content or curriculum development? Do they know test construction or the interpretation of standardized tests?

Do they know about learning theory, or understand how to manage a class of 30 unique individuals? Do they know about diagnosing various handicapping conditions for developing appropriate educational programs? Do they have a repertory of teaching or instructional strategies?

We certainly applaud the efforts of Senators Glenn, Pell, Congressman McCurdy, and others who appreciate that the NDSL program is a successful strategy for recruiting persons into teaching.

It is, however, a long-range strategy. Under such a program, it will be 3 to 5 years before the first group of students finish their preparation and enter the classroom. We cannot wait an additional 5 years for those needed teachers.

We would like to encourage the immediate establishment of a program of teacher fellowships, to be made available to qualified students who agree to a minimum commitment as a classroom teacher.

Such a program could be implemented through a system of matching grants to the States, to be awarded by the Governor as fellowships to qualified undergraduate students seeking careers in teaching.

We believe that Congress must exercise its authority to assess current and future supply and demands for teachers. States and school districts should be encouraged to provide in-service training that meet highest academic and professional standards.

Pilot programs which stress school, university, industry cooperation should be identified and supported. There should be sufficient funding for basic and applied research in mathematics, science, education and technology as they are translated into programs for elementary and secondary schoolchildren.

Teachers should be offered sabaticals and stipends to pursue additional training while business and industry and institutions of higher education and other such organizations should be given incentives, through tax credits or other means, to provide appropriate learning opportunities.

A number of States have devised programs which attempt to solve their own shortage problems, but may cause difficulty for other States. Georgia's active recruitment of math and science teachers has hurt other States.

I think we must direct our efforts to keeping those well-qualified teachers in the classroom and encouraging young people to consider teaching as a career.

We must begin by making the general public, and particularly parents, aware of the cost of apathy. We must publicize the economic and social cost inherent in an educational system which cannot adequately prepare its children for the present and future technologies.

We must direct special attention to our elementary schools where young boys and girls develop many of their attitudes toward science, mathematics, and technology.

We need incentives for the math and science teachers who will be graduating from our colleges and universities this year to enter the classroom. We cannot afford to have half of them enter professions other than teaching.

Business and industry partnerships are one option. Another would be to assist school districts and institutions of higher education in establishing support systems for these new teachers.

Of immediate concern must be the in-servicing of existing mathematics and science teachers to keep them in our profession. We encourage you to consider the former National Science Foundation model of summer institutes for elementary and secondary school teachers as a viable and much-needed program to upgrade skills in the classroom and to retrain surplus teachers in one area to fill positions in high-demand areas.

In such a program, the college of education, serving as a coordinating point, can work with faculty in the colleges of arts and sciences to translate the resources of the university into the needs of the school systems and teachers.

The best teachers cannot serve the needs of the students without adequate and updated materials. We believe the Congress should consider proposals to provide incentives to business for sharing high-technology equipment with elementary and secondary schools.

These provisions of such a bill should also be extended to the teacher training institutions, so that we can prepare our graduates or those who come to us for in-service and the state-of-the-art technology.

State-by-State solutions should complement, not replace, the Federal response to what is a national problem demanding national attention and a national solution.

It is time for a comprehensive look at all of the factors surrounding teacher recruitment, training, placement, and retention.

I ask that the Congress make a commitment to the children, the schools and teachers, both present and future, to develop a comprehensive policy which will touch all points in a teacher's development and to make this commitment your highest priority for this Congress and for the next.

Thank you.

[The prepared statement of Anne Flowers follows:]

Prepared Statement of Dr. Anne Flowers, Dean, School of Education, Georgia Southern College, Statesboro, Ga., and President-Elect, The American Association of Colleges for Teacher Education

Good morning. I am pleased to have the opportunity to testify before this joint hearing of the House Subcommittee on Elementary, Secondary and Vocational Education and the Subcommittee on Postsecondary Education.

My name is Anne Flowers. I am dean of the School of Education at Georgia Southern College in Statesboro, Georgia. I am also President-Elect of the American Association of Colleges for Teacher Education. AACTE is a national professional organization of colleges and universities dedicated to teacher preparation and renewal; collectively our member institutions prepare over 80 percent of all new teachers each year.

I am particulary pleased to have an opportunity to join you today because I know you and your colleagues in the Congress share with me and my colleagues in the education profession a common goal which, to quote Mr. Simon, is to "ensure competence and encourage excellence of teachers."

I have been invited to discuss the nature of shortages of mathematics and science teachers, and, from the perspective of higher education how problems such as this may be addressed. Let me assure you, the shortage of qualified teachers is real, and it is a problem likely to grow during the coming decade.

President Reagan, speaking before a National Academy of Sciences Convocation on Science and Mathematics in the Schools said, "Although there has been increasing discussion in recent months about our ability to train adequate numbers of professional engineers and scientists, we are only now beginning to see serious discussion of the far greater problem of education at the precollege level. This public awareness—and I hope public action—is long overdue. . . . This country was built on American respect for education. . . . Our challenge now is to create a resurgence of that thirst for education that typifies our nation's history.[1] We agree with the President that the time to address the training of adequate numbers of education professionals is long overdue.

Between 1971 and 1980 the annual number of new teacher graduates decreased from 314,000 to 159,000. In large measure this decline was brought on by students' enrollment in other fields of study in response to teacher surplus in the early 1970s.[2] The trend continues. Last fall the percentage of high school seniors indicating an interest in teaching fell to only 2.2 percent of men and 7.4 percent of women, a decline of 50 percent since 1973.[3] In 1981 43 states reported a shortage of qualified mathematics teachers and between 1970 and 1980 there was a 77 percent decline nationwide in the number of secondary school mathematics and science teachers being trained.[4] This is compounded by the fact that only 600, or 40 percent of the nation's teacher preparation institutions currently graduate math teachers and only 55 percent of these graduates actually enter the profession.[5]

In my own state of Georgia, only 70 prospective mathematics teachers were graduated from our colleges and universities during the 1981–1982 school year. Of these only 60 percent of them actually entered the classroom, and the drop-out rate for the first year was 35 percent with a projected loss of 10 percent per annum for future years. To supplement this number, Georgia actively recruits from other states. Many of our new teachers come to Georgia from the midwest, Michigan, Indiana, Illinois, and Minnesota. This year we will have the mathematics and science teachers we need, but at the expense of some of our neighbors to the North.

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[1] "Science and Mathematics in the Schools." Report of a Convocation. National Academy of Sciences/National Academy of Engineering. May 1982, p. 1.

[2] Grayheal, William S., "Teacher Supply and Demand in Public Schools, 1980–81." National Education Association, Washington, D.C., 1981.

[3] "Education Daily," Wednesday, September 22, 1982, "SAT Scores Rise for First Time in 19 years."

[4] "Mathematics Teacher Shortage, An NCTM Fact Sheet," National Council of Teachers of Mathematics, Reston, Virginia, August 1982.

[5] "Mathematics Teacher Shortage, An NCTM Fact Sheet."

Attrition among practicing teachers aggravates the shortage. In 1981 almost five times more science and mathematics teachers left to take non-teaching jobs than teachers in other disciplines.[6] Further, we are facing a "graying" of our teaching force which is especially acute in scientific and technical areas to the point that the average age of science teachers is 41.[7] The replacements for these trained teachers are often inadequately prepared. Of the teachers newly employed in 1981–82 to teach high school mathematics or science, 50 percent were formally unqualified and are teaching with emergency certificates.

SHORTAGES IN OTHER SUBJECTS

An undersupply of mathematics and science teachers is part of an overall shortage. Georgia was able to find enough individuals to fill our vacancies for the opening of school this September. But what about next year? Where will the replacements come from for the anticipated 35 percent of these teachers who will leave the classroom? Of even more immediate concern, how are we to address undersupply in areas other than mathematics and science? The latest vacancy survey for teaching positions in Georgia, completed just last week, indicated shortages in the following areas: Speech pathology; Physical Therapy; Integrated Special Education; Behavior Disorders; Learning Disabilities; Early Childhood (k-4); and Industrial Arts.

According to a recent survey of teacher supply and demand by field and region conducted by the Association of School, College and University Staffing, Georgia's shortages are not unique.[8] In addition to the areas just mentioned, a number of other teaching fields have national shortages of qualified personnel: Vocational Agriculture; Bilingual Education; Special Education (emotionally disturbed); Special Education (multi. Handicapped); Special Education (MR); Special Education (gifted); Special Education (reading); Business; and Data Processing.[9]

Clearly solutions limited to one discipline won't be much consolation to school districts in Illinois, and Kentucky who can't find teachers for their vocational agriculture program; or for their gifted and talented programs; or for their handicapped children. In addition, teachers prepared and hired in the 1950's in response to the severe shortage at that time are now within 10 years of retirement. It takes four to six years to train a teacher for initial entry into the classroom. I suggest that now is the time to begin to prepare for the replacement of these individuals.

THE NEED FOR A COMPREHENSIVE APPROACH

A number of solutions have been proposed for the mathematics and science teacher shortage . . . many are excellent, but none should be considered as an esclusive remedy. Several of the proposals put forward by the Congress or educational policy makers will address the teacher shortage issue in the long run while others may have more immediate impact. Both need to be reviewed and considered within the larger context of ensuring competence and excellence of teachers.

The issue Congress really needs to address is the development of a comprehensive federal education policy which will ensure the preparation of qualified teachers to meet current and future demand. To address recruitment into the professioon, the quality of preparation, the nature of the classroom setting in which we place these teachers, the necessary support services for them, and teacher retention.

The conditions of practice significantly affect our ability to recruit and retain sufficient numbers of qualified teachers. We have high expectations of our teachers: superb academic preparation from the schools of arts and sciences, strong professional preparation and sufficient supervised experiences in the classroom, and expertise in the latest in science and technology. Yet we supply out-of-date equipment and materials and pay them far less than others with similar background and education. Why are we suprised when these people choose not to remain in the classroom?

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[6] "Science and Mathematics in the Schools," p. 5.

[7] Klein, Sarah E., Testimony to Committee on Labor and Human Resources, U.S. Senate, 1982, p. 6.

[8] "Teacher Supply/Demand by Field and Region," Education Week, February 17, 1982.

[9] Peseau, Bruce, and Orr, Paul. "The Outrageous Underfunding of Teacher Education," PKD 62,2. October 1980, pp. 100–102.

I would caution you to beware of simplistic solutions which address only a small component of the problem or themselves create greater problems.

Certification waivers are one such issue. An emergency or provisional certificate is an inappropriate response to the shortage problem. Knowledge of subject matter is not sufficient preparation for the teaching of it. How can we have both a commitment to educational excellence and tolerate untrained teachers in our schools? Bright, caring intelligent arts and science graduates are abundant, but are they qualified? We must ask ourselves . . .

Do they know anything about sequencing of content or curriculum development?

Do they know anything about test construction or the interpretation of standardized tests?

Do they know anything about learning theory or understand how to manage a class of 30 unique different individuals?

Do they know about diagnosing various handicapping conditions or developing appropriate educational programs?

Do they know anything about the laws that shape our educational programs?

Do they have a repertory of teaching or instructional strategies to use in various situations and with different children?

LONG RANGE STRATEGIES

One of the "long range" strategies receiving considerable attention is the proposal to expand the loan forgiveness provisions of the existing National Direct Student Loan program or to create a new program modeled on NDSL for mathematics and science teachers.

We applaud the efforts of Senators Glenn, Pell and Congressman McCurdy and others who appreciate that the NDSL program is a successful strategy for recruiting persons into teaching. It is, however, a long range strategy. Under such a program it will be three to five years before the first group of students finish their preparation and enter the classroom. In fairness to the children now in elementary and secondary schools, I do not feel we can wait an additional five years for those needed teachers until this program comes to fruition. In addition, expanding the provisions of NDSL for mathematics and science teachers does nothing to address current and future shortages in other areas. Recognizing that the Higher Education Act which authorizes the NDSL program will not be considered again by the Congress for at least a year, we would like to encourage the immediate establishment of a program of teacher fellowships to be made available to qualified students who agree to a miminum commitment as a classroom teacher. Such a program could be implemented through a system of matching grants to the States. These grants would be awarded by the Governor as fellowships to qualified undergraduate students seeking careers in teachers. These awards would allow the Governors to target specific shortage areas. Federal support for this initiative will assist those States where current economic conditions prevent the implementation of such a program without external support.

We believe that the Congress must exercise its authority to assess current and future supply and demand needs for teachers. States and school districts should be encouraged to provide inservice training that meets the highest academic and professional standards. Pilot programs which stress school-university-industry cooperation should be identified and supported. There should be sufficient funding for basic and applied research into mathematics, science, education and technology as they are translated into programs for elementary and secondary school children. Teachers should be offered sabaticals and stipends to pursue additional training while business, industry, institutions of higher education and other such organizations should be given incentives, through tax credits or other means, to provide appropriate learning opportunities.

SHORT TERM SOLUTIONS

Elementary or Secondary school children who returned to school in September to learn they wouldn't have science class because no teachers were available can't wait for long term solutions. In response, a number of states have devised programs which attempt to solve their own shortage problems in that state or locality. Georgia's active recruitment of mathematics and science teachers exacerbates the problem in Minnesota, Michigan, Indiana, Ohio, Illinois and elsewhere.

Rather than recruiting and employing unqualified persons, we must direct our efforts to keeping those trained individuals who are in or about to enter teaching, and to reattracting those teachers who have left the profession for positions in business and industry.

1. We must begin by making the general public and particularly parents aware of the cost apathy. We must publicize the economic and social costs inherent in an educational system which cannot adequately prepare its children for the present and future technologies. And, we must direct special attention to our elementary schools where young boys and girls develop many of their attitudes toward science, mathematics and technology. These subjects, like foreign language instruction, when introduced early and properly are neither difficult nor frightening.

2. We need incentives for the mathematics and science teachers who will be graduating from our colleges and universities this year to enter the classroom. They are a precious resource and we can't afford to have half of them enter professions other than teaching. Business and industry partnerships, such as the tax credits suggested by Mr. McCurdy, are one option. Another would be to assist school districts and institutions of higher education in establishing support systems so these new teachers will have the academic and professional assistance they need during their critical first years. Enabling university faculty, peers and system supervisors to assist the beginning teacher while having a reduced teaching-load would be a way to implement this network.

3. Of immediate concern must be inservicing existing mathematics and science teachers to keep them in the profession. Programs that address both their academic needs and their professional needs are essential. We believe that states should be given incentives to conduct programs with school districts and IHEs to deliver this needed inservice. We encourage you to consider the former National Science Foundation model of summer institutes for elementary and secondary school teachers as a viable and much needed program to upgrade the skills of teachers in the classroom. At the same time the institutes could retrain surplus teachers in one area to fill positions in high demand areas. Through such institutes our colleagues in the colleges of science will have an opportunity to prepare students in subject matter such as mathematics, chemistry, computer technology or other disciplines. Teacher educators will help these students understand how they can translate their scientific or technical knowledge into programs which will generate excitement and an interest in a fourth grade general science class.

The college of education, serving as a coordination point, can work with faculty in the colleges of arts and science to translate the resources of the university into needs of school systems and teachers.

4. Even the best teacher cannot serve the needs of his or her students without adequate and up-to-date materials. We believe the Congress should consider proposals to provide incentives to businesses for sharing high technology equipment with elementary and secondary schools. We stress, however, the provisions of such a bill should also be extended to the teacher training institutions so we can prepare our graduates or those who have come to us for inservice in state-of-the-art technology.

State-by-state solutions should complement, not replace, the federal response to what is a national problem demanding national attention and a national solution. It is time for a comprehensive look at all of the factors surrounding teacher recruitment, training, placement and retention. Quick fixes to the crisis of the moment won't work. This is not an easy task, nor will it be without cost. As long as we spend less to train a teacher than we spend to educate a third grader, we can't expect to have the kind of quality personnel in our classroom that these children deserve. I ask that the Congress make a commitment to the children, schools and teachers, both present and future, to develop a comprehensive policy which will touch all points in a teacher's development and to make this commitment your highest priority for this Congress and the next.

Mr. SIMON. Thank you, Dr. Flowers.

The final member of the panel, Dr. Paul Taylor, the director of the division of science, for the North Carolina State Department of Public Instruction.

I know our colleague, Ike Andrews, would particularly want to be welcoming you. I know he referred to your testimony earlier, and he apparently has a conflicting meeting right now, but we can welcome you specifically on behalf of our colleague.

STATEMENT OF PAUL TAYLOR, DIRECTOR, DIVISION OF SCIENCE, NORTH CAROLINA STATE DEPARTMENT OF PUBLIC INSTRUCTION

Dr. TAYLOR. Thank you, sir.

Mr. Chairman, members of the subcommittees, I am Paul Taylor, director of division of science, with the Department of Public Instruction in North Carolina.

I am pleased to have this opportunity to talk to you about math and science education at the national level, in general, and in North Carolina in particular.

I will restrict my comments to a review or a summary of my——

Mr. SIMON. Your full statement will be entered into the record.

Dr. TAYLOR. When science and math education are discussed or written about today, two things immediately surface: shortage of teachers and low student achievement in these areas, especially in relation to the achievement of students in countries like Japan, Russia, and Germany.

Based on reports and also on personal knowledge, there is a critical shortage of science and math teachers in our State, as well as in the Nation. And yet, the public is often misled about the shortage of teachers and the demand for such by headlines such as too many teachers are being produced by colleges and universities, or a local system has been flooded with applications for teaching positions.

These headlines are true. Ironically, they are misleading, though, in that they speak about the total sum of teachers, not being specific to the various disciplines like science and math education.

To understand the headlines, one must analyze specific areas like science and math. The primary reasons for the shortage of math and science teachers, as I see it, are too few persons with backgrounds in science and mathematics are produced by the colleges and universities to meet the demands of the educational field and of industry, and too few of those who become certified in science and math actually go into teaching.

Third, many teachers leave the profession during or immediately after the first year of teaching. Many of the people who leave the teaching profession leave for one or both of two reasons, factors related to finances, or job stress. You have heard the term "burnout," that applies in the case of teachers, not only in science and math, but others.

At its annual convention in Los Angeles, in 1980, the National Association—National Educational Association—reported on a study that reveals a shortage of science teachers, as well as some in other areas.

They stated that one reason for the shortages is that salaries paid graduates for teaching in those areas are lower than those they can demand in industry. More than 40 percent of the respondents to an NEA opinion poll said they would not become teachers if they could go back to college and start over. That indicates dissatisfaction with the job.

Now, some facts relating to North Carolina. In 1980–81, in grades 7 through 12, only 73 percent of the science classes and 74 percent of the mathematics classes were taught by appropriately certified teachers. That resulted in almost 3,800 science classes and 4,000 mathematics classes being taught by inappropriately certified teachers.

During that year, there were approximately 3,600 science teachers in those grade levels, 7 through 12. Seventy-one percent were certified in some area of science, twenty-nine percent were certified in other areas, not certified in any area of science.

With the math situation with better than 4,000 teachers, 60 percent were noncertified or not certified in math. Only 60 percent were certified in math and 40 percent were not certified in any math.

It is interesting to look at the sex distribution of the subjects—by subjects. In science during that year, the females and males, it was almost even, 52 percent female, 48 percent male.

With mathematics, it was a little different, 66 percent females, 34 percent males.

The average mean—the average or mean teaching experience during that year for science teachers was 11 years, math teachers, 10.4. That number is creeping up, indicating that teachers who are there are tending to stay a little longer.

The number of graduates receiving secondary science majors from North Carolina colleges and universities and becoming eligible for certification decreased by 62 percent from 257 to 98 from 1970 to 1980; that was in science.

Secondary mathematics majors decreased by 72 percent, from 299 to 84, during the same period of time. Fifty-nine new mathematics and 46 new science teachers were employed by schools throughout the State for the school year 1980–81.

Now, I would like to mention some factors which I think are present and hamper the advancement of science and math education. We have all talked about that shortage of certified, qualified teachers. Lack of sufficient funds for personnel equipment materials and facilities, decreasing student enrollments is an economic factor with our local school systems, industry's need for more math and science graduates.

Successes of the past, it may be a little hard to conceive of to begin with, but I think maybe we have been successful, too successful in the past in some cases. Scientific and technological breakthroughs became common occurences, and in some cases, I think, may have brought on apathy. We may be suffering from some of this.

Supervision at the secondary level is diminishing, not only in our State, but across the country. Software lags hardware technology. That presents a problem.

Greater employment opportunities are available to women now than were available 15 or 20 years ago. That phenomenon is a plus in one sense, which I think all of us are proud that the situation exists and yet it does hamper the situation of getting sufficient teachers into the teaching field.

Now, I would like to mention a few efforts that are occuring in North Carolina to cope with the situation that we are all talking about. A revolving loan fund for prospective teachers was established by the North Carolina General Assembly in 1957.

Any resident of North Carolina who wishes to prepare to teach in the public schools of our State can apply for one of these loans. When it was established in 1957, $350 was the maximum amount provided per academic year. That maximum has been raised and is presently at $1,500 per academic year.

It has the forgiveness clause attached to it, as has been spoken about here today. Loans from this fund are also available to teachers who are already in the teaching field and wish to go back in the summer to improve their proficiency in teaching or maybe change their certification.

These loans are set up on a forgiveness basis, as I mentioned, if they go into teaching in North Carolina schools or into a military school operated on a military reservation in the State.

Otherwise, if they are to be paid back, it will be paid back plus 6 percent interest after the loan has been used. The loan must be paid back or satisfied within 7 years after it has been used.

These loans are awarded according to a set of criteria. One of those criteria is the area of subjects of instruction which the demands are greatest, and for the past few years, priority has been given to the area of science and mathematics education.

During the decade, 1972 to 1981, math applicants were awarded 255 loans, science applicants, 108 loans. A grand total of 2,229 loans were made during that time.

Another effort in North Carolina is assistance from the North Carolina Board of Science and Technology, which is an advisory board of the governor. In the fall of 1980, a committee representing this board made up of members of the board from organizations in the State and members of the Department of Public Instruction was established to see what could be done to come up with recommendations for the improvement of elementary and secondary science and math education.

The committee was active for approximately 2 years. The final conclusions and recommendations were categorized under basically four headings: One, alleviating the shortage of science and mathematics teachers, and two recommendations under this which are of special interest are adopt a higher schedule, higher salary schedule for science and mathematics teachers and place science and mathematics teachers on an 11- or 12-month contract basis; two, a grants program for teachers of physical science and mathematics, and the reason for physical science here is that the biological science situation is not as grave as the physical science situation is.

As a result of the work there, a bill has been written and plans are for it to be introduced into the general assembly when it reconvenes in January. If such a bill is passed, it would provide scholarship loans to teachers to go back in the summer to improve their proficiency or change certification to science and/or mathematics.

Three, local improvement projects, encouragement is given to our local school systems to form a committee at the local level and strive for a program of improvement with the use of very few additional funds.

One school has responded, one school system, and has an established committee working on this presently.

Four, teacher qualifications. The committee encourages the State department of public instruction and the State board to review certification requirements and bring them up to date.

In response to that effort, and in order to follow up, the Governor has appointed a task force on science and technology to initiate effective programs in the area of elementary and secondary science and mathematics education, research in higher education and technological innovation.

This task force, in conjunction with the State Department of Public Instruction, will, in the near future, begin work in these areas.

Curriculum studies: A curriculum study was called for in our State by the State board of education and approved by them and supported by our State superintendent and over a period of about 18 months, beginning in 1980, a curriculum study was done and recommendations were brought forth and presented to the State board of education in June.

Some of those recommendations of particular interest I will mention here pertain to increasing science teacher salaries, improving staff development activities, revising teacher certification requirements, and safety.

A similar study is under way in mathematics, and it is in anticipated that it will be completed by June 1983.

Another effort in our State which we are very proud of is the North Carolina School of Science and Mathematics. One June 16, 1978, at the request of the Governor, the general assembly established the North Carolina School of Science and Mathematics. This residential school for gifted and talented high school boys and girls with strong interest and unusually high potential in science and mathematics, is located in Durham.

The school opened its doors in the fall of 1980. It is presently in its third year of operation with approximately 400 students, with an objective of increasing that over the next few years to about 750 to 900 students.

One of the school's interests is to strive for improved science and math education in the elementary and secondary schools throughout the State. Another item, extended term for science and mathematics teachers.

The concept of providing science and math teachers with 12-month employment is being studied. It is anticipated that the next general assembly which convenes in January will be asked to appropriate funds to offer 12-month employment to one-third of the science and mathematics teachers in grades 9 through 12.

Those with extended employment terms would teach summer school and, in some cases, be permitted to attend colleges and universities to improve their proficiency as science and math teachers.

In North Carolina, the enrollments have declined in recent years. In grades 9 through 12, during the period of 1977 through 1982, the overall enrollment declined 8 percent. The number of students taking science declined 2 percent during that period, those taking mathematics declined 3.5 percent during that period of time.

We have more figures in detail on that which are in the written statement.

One last component that I wish to summarize here of my presentation, and those of you who have access to it and have looked at it, may realize that from the tone in which it is written that we fully recognize the problem that we have been discussing here today and are eager and anxious to get things moving to do something about it.

Let me quote a statement from my presentation.

> The way to improve student achievement in science and math is to expose the students to the subject matter longer, in the presence of better teachers.

It is a simple statement, but it will take a lot of resources and a lot of work to accomplish it. However, I wish to offer a conceptual plan for accomplishing such a goal.

One, declare the teaching of science and mathematics essential to national security.

Two, mandate that all science and math teachers by a certain date be appropriately certified for their teaching assignments.

Three, require a 5-year undergraduate program for science and mathematics teachers, with the fourth and fifth years being paid for with Government funds. And this type of fund being proposed would be on a forgiveness basis, also.

Four, permit any math or science teacher to return to a State-supported teacher-training institution, tuition-free, to further his or her competence in math or science teaching, or to change one's certification to science or math.

Five, provide 12-month employment for science and math teachers and require them to be involved in staff development activities relevant to their assignments each year. Six, adopt one of two options by which science and mathematics teachers are paid base salaries on supply and demand, or increase present salaries by at least 50 percent.

And seven, require each teacher to take at least one course in science and one in mathematics each year in grades K through 12, provide students in high school the opportunity to take as many as three math and/or three science courses per year if they so desire.

While it is not suggested that the Federal Government mandate this plan, if States elect to implement such a plan, financial help from the Federal Government will be essential. Additional funds will be required for teacher staff development, extended undergraduate programs, facilities and equipment for upgrading laboratories, instructional supplies, and for increasing salaries for math and science teachers.

Mr. Chairman, we in North Carolina know there is a problem, we know a lot about what the problem is, we are anxious to get things done, and we think we share the same interest and concern for the shortage of science and math teachers and for the low achievement which is occurring among our students with our other States in the Union.

This concludes my presentation.

[The prepared statement of Paul Taylor follows:]

PREPARED STATEMENT OF PAUL H. TAYLOR, DIRECTOR, DIVISION OF SCIENCE, DEPARTMENT OF PUBLIC INSTRUCTION, RALEIGH, N.C.

SCIENCE AND MATHEMATICS EDUCATION

Mr. Chairman, Members of the Subcommittees, I am Paul Taylor, Director, Division of Science, North Carolina Department of Public Instruction. I am pleased to have the opportunity to testify before the Subcommittee on Elementary, Secondary, and Vocational Education and the Subcommittee on Postsecondary Education on science and math education. This morning, I would like to talk to you about science and math education at the national level in general, and in North Carolina in particular.

When science and math education are discussed or written about today, two things immediately come to the surface: (1) shortage of teachers; and (2) low student achievement, especially in relation to the achievement of students in countries like Japan, Russia, and Germany.

Based on numerous reports and personal knowledge, there is a critical shortage of qualified science and math teachers throughout this country. And yet, the public is often misled about the supply of, and demand for, science and math teachers by headlines such as: "Too Many Teachers are Being Trained by Colleges and Universities," "Teachers Can't Find Jobs," "Schools are Flooded with Teacher Applications." It is ironic that the headlines are true because they refer to the sum total of teachers in all areas. The headlines are misleading because they do not refer to teachers of specific disciplines. The situation can be understood only through analyzing data relating to specific discipline areas such as mathematics and science.

The primary reasons for the shortage of math and science teachers are: (1) too few persons with backgrounds in math and/or science are produced by colleges and universities to meet the demand for teachers and for industry employees, (2) too few[1] of those who become certified in science and/or math actually go into teaching, and (3) many teachers leave the profession after only teaching one or two years.[2]

Many of the persons leaving the teaching profession leave for one or both of two reasons--factors related to finances and job stress. At its

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[1] In North Carolina, only about 50%.

[2] As recent as three years ago in North Carolina about 1/3 of the beginning science teachers in grades 7-12 were leaving the profession during or immediately after the first year of teaching.

1980 annual convention in Los Angeles, the National Education Association reported on a study which reveals a shortage of science and math teachers, as well as a shortage in vocational and technical areas. One reason for the shortages, the NEA says, is that salaries paid graduates for teaching in those areas are lower than those they can command in industry. More than 40% of the respondents to an NEA opinion poll said they would not become teachers if they could go back to college and start over.

NORTH CAROLINA FACTS

In 1980-81, the North Carolina situation in grades 7-12 was less than desirable:

1. Only 73% of the science classes and 74% of the math classes were taught by appropriately certified teachers.
2. There were 3,770 science classes and 4,010 mathematics classes taught by inappropriately certified teachers.
3.

	Teachers	Certified in Science/Math	Not Certified in Science/Math
Science	3,587	71%	29%
Math	4,235	60%	40%

4. Teachers: Sex Distribution by Subjects

	Females	Males
Science	52%	48%
Math	66%	34%

5. Teachers: Experience by Sex

	0-2 years		9-11 years		34+years	
	F	M	F	M	F	M
Science	50	50	49	51	63	37
Math	65	35	66	34	68	32

6. Teachers: Average (Mean) Teaching Experience

Science 11 years
Math 10.4 years

The number of graduates receiving secondary science majors from North Carolina colleges and universities, and becoming eligible for teacher certification, decreased by 62% from 257 to 98 from 1970 through 1980; the secondary mathematics majors decreased by 72% from 299 to 84 during the same period of time. Fifty-nine new mathematics and 46 new science secondary teachers were employed by schools throughout the state for the school year 1980-81.

FACTORS THAT CONTINUE TO HAMPER THE ADVANCEMENT OF SCIENCE AND MATH EDUCATION

1. Shortage of certified/qualified science and math teachers.
2. Lack of sufficient funds for personnel, equipment, materials, and facilities.
3. "Back to basics" movement (hurting science).
4. Decreasing student enrollments (economical).
5. Industries' needs for math and science graduates.
6. Attitudes among students and some adults--"You're never going to need it."
7. Teachers being assigned out-of-field.
8. Stigma--"Science and math are hard."
9. Competency testing in other subjects (hurting science).
10. Successes of the past--scientific and technological breakthroughs became common occurrences.
11. Supervision at secondary level diminishing.
12. Software lags hardware technology.
13. Much of the public still illiterate in science and math.
14. Greater employment opportunities available to women.

NORTH CAROLINA EFFORTS TO IMPROVE SCIENCE AND MATH EDUCATION

1. Scholarship Loan Fund for Prospective Teachers

A revolving ~~loan~~ loan fund for prospective teachers was established by the North Carolina General Assembly in 1957. Any resident of North Carolina who is interested in preparing to teach in the public schools of the state is eligible to apply in writing to the State Superintendent of Public Instruction for a scholarship loan. In the beginning, the maximum amount of a loan was $350 per academic year. Today (became effective July 1, 1982) the maximum amount is $1,500 per academic year.

Loans are available also to persons who are already teaching and wish to return in the summer to take additional undergraduate courses. Such loans are limited to $300 per six semester hours of credit.

Loans from this fund bear interest at the rate of 6% per annum from and after September 1 following fulfillment by a prospective teacher of the requirements for a teacher's certificate based upon the bachelor's degree. In the case of persons already teaching in the public schools, who obtain scholarship loans, such loans bear interest at the rate of 6% per annum from and after September 1 of the school year beginning immediately after the use of such scholarship loan.

Each recipient of a scholarship loan under the provisions of this program is eligible for scholarship loans each year until he or she has qualified for a teachers certificate based upon a bachelor's degree, but he or she is not eligible for more than four years.

Loan recipients may meet their loan obligation through teaching in a public school system or in a school operated by the U.S. Government on a military reservation in North Carolina. For each full year taught, the recipient of a scholarship loan receives credit upon the amount due by reason of such loan equal to all interest accrued upon the loan to that time, plus a credit of $1,500 upon the principal amount of such obligation or lesser amount as may remain due upon said principal.

All teaching service for which the recipient of any scholarship loan is obligated must be rendered within seven years after completion of the use of such scholarship loan.

Loans are awarded according to a set of criteria. One of those criteria is the areas or subjects of instruction in which the demands for teachers are greatest. For the past few years, applicants who agree to concentrate their studies in the field(s) of science and/or math have received priority consideration.

During the decade 1972-81, math applicants were awarded 255 loans; science applicants 108 loans. A grand total of 2,229 loans were made during that time.

2. Assistance From the North Carolina Board of Science and Technology

In the fall of 1980, a Committee on Science and Mathematics Education was established jointly by the North Carolina Board of Science and Technology and the North Carolina Department of Public Instruction. Its goal was to develop procedures for increasing the interest and proficiency of high school graduates in North Carolina in science and mathematics.

The Committee was active for approximately two years. The final conclusions and recommendations of the Committee for improving science and math education in North Carolina are summarized under four headings:

a. Alleviating the Shortage of Science and Mathematics Teachers

Two recommendations of special interest under this heading are--

(1) Adopt a higher salary schedule for science and mathematics teachers.

(2) Place science and mathematics teachers on 11- or 12-month contracts.

b. A Grants Program for Teachers of Physical Science and Mathematics

It is proposed that the State Board of Education award $1,000 scholarships to physical science and mathematics teachers in grades 6-12 to enable them to attend courses and workshops during the summer and the academic year at North Carolina colleges and universities. In response to this recommendation, a Bill has been written and plans are for it to be introduced when the General Assembly convenes next year.

c. Local Improvement Programs

The goal of these programs is to stimulate and nurture increased commitment to science and mathematics education at the local level. Funds have been, and are being, sought from private sources to assist with this recommendation. In response to this recommendation, one school system is implementing a program of improvement with little or no additional funds.

d. Teacher Qualifications

The Committee recommended that the State Board of Education determine the qualifications required for proper instruction in science and mathematics, and work with colleges of education and college science and mathematics departments to ensure that appropriate science and mathematics courses are included in teacher education curricula.

In order to follow-up on the above recommendations and other issues, the Governor has appointed a Task Force on Science and Technology to initiate effective programs in the areas of elementary and secondary science and mathematics education, research and higher education, and technological innovation. This Task Force, in conjunction with the State Department of Public Instruction, will serve as a focal point for statewide efforts to achieve excellence in science and mathematics education. Programs are now developing to foster relationships among various segments of local communities, including educators, parents, business and industry leaders, and scientists and engineers, to address local needs in science and mathematics education. A series of regional forums will be held across the state to encourage local awareness and participation in this process.

3. Curriculum Studies

A Science Curriculum Study Committee was appointed by State Superintendent of Public Instruction, Craig Phillips, in 1980 to do a thorough review of the science program in the state's public schools and to make recommendations for the improvement of science education in the state. The Committee was composed of 24 members representing teachers, supervisors, principals, scientists, science educators, parents, and students from across the state. Support and coordination was provided by the staff of the Division of Science of the Department of Public Instruction.

Three subcommittees were organized within the Committee to address curriculum, staff, and facilities. Each subcommittee identified major questions, gathered and analyzed data, and developed recommendations for improving science education.

The Committee was active for about 18 months. The Committee's final report, containing its recommendations, was presented to the State Board of Education in June 1982. The report is presently under study and plans are being made to implement some of its recommendations.

The recommendations are of a broad nature. Some of particular interest pertain to increasing science teacher salaries, improving staff development activities, revising teacher certification requirements, and safety.

A similar study is under way in the area of mathematics. It is anticipated that it will be completed by June 1983.

4. The North Carolina School of Science and Mathematics

On June 16, 1978, at the request of Governor Hunt, the General Assembly established The North Carolina School of Science and Mathematics. This residential school for gifted and talented high school boys and girls with strong interests and unusually high potential in science and mathematics, located in Durham, presents a challenge of attainment of educational excellence to its students, to their parents, to the faculty, as well as to the educational, scientific, and civic communities throughout the state and nation.

The school opened its doors to students in the fall of 1980. It is in its third year of operation with approximately 400 students.

One of the school's interests is to strive for improved science and math education in the elementary and secondary schools throughout the state. Computer institutes have been conducted at the school by its staff during the past two summers for science and math teachers from schools across the state. Staff development activities of a different nature are being planned for next summer for similar teachers.

5. Extended Term for Science and Mathematics Teachers

The concept of providing science and math teachers with 12-month employment is being studied. It is anticipated that the next General Assembly (convening in January 1983) will be asked to appropriate sufficient funds to offer 12-month employment to 1/3 of the science and math teachers in grades 9-12. Those with extended employment terms will teach summer school and, in some cases, be permitted to attend colleges and universities to improve their proficiency as science and math teachers.

STUDENT ENROLLMENTS DECLINE IN NORTH CAROLINA SCHOOLS

The total student enrollment in grades 9-12 declined 8% from 370,543 to 341,165 from 1977-78 to 1981-82. During the same period, students taking mathematics declined 3.5% from 261,524 to 252,300; while students taking science declined 2% from 225,920 to 221,386.[1] The above figures may be seen in more detail on the next two pages.

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[1] Figures were obtained from reports filed at the end of the first month of school.

SCIENCE MEMBERSHIP SUMMARY: GRADES 9-12
North Carolina Public Schools

Science Courses	1977-78	1978-79	1979-80	1980-81	1981-82
Physical Science	72,922	74,698	71,168	68,394	69,900
Biology	103,093	99,952	101,554	94,245	91,334
Advanced Biology (2nd year)	7,830	8,014	7,994	7,340	6,754
Chemistry	23,830	24,116	23,765	24,204	23,868
Advanced Chemistry (2nd year)	1,406	1,533	1,612	1,603	1,636
Physics	6,432	6,888	6,811	7,111	7,037
Advanced Physics (2nd year)	68	63	171	184	119
Astronomy					177
Geology					272
Applied Science	936	1,019	1,214	1,338	2,024
Marine Science	676	748	815	1,142	829
Special Interest Science	3,531	4,070	3,447	3,428	4,121
Environmental (Ecology)	3,276	2,600	2,611	2,496	2,324
Anatomy and Physiology	1,766	1,760	2,032	1,871	1,844
Aviation Science	176	223	116	139	147
Totals	225,920	225,684	223,310	213,495	221,386
Total Student Enrollment (9-12)	370,543	367,502	358,829	349,013	341,165

MATHEMATICS MEMBERSHIP SUMMARY: GRADES 9-12
North Carolina Public Schools

Mathematics Courses	1977-78	1978-79	1979-80	1980-81	1981-82
General Math I	48,053	53,346	48,308	43,542	41,250
General Math II	15,409	17,591	15,634	15,759	15,930
General Math III	3,494	3,361	3,685	4,587	4,470
General Math IV	1,726	1,270	1,502	1,806	643
Algebra I	55,568	51,720	49,587	49,222	50,599
Introductory Algebra Part I	28,721	19,399	17,790	16,250	17,178
Introductory Algebra Part II		9,534	9,129	8,935	7,908
Geometry	41,212	40,633	40,716	38,748	39,974
Applied Vocational Math	2,229	2,810	2,691	2,079	1,884
Algebra II	28,390	29,669	29,969	29,646	27,866
Algebra II/Computer Programming	411	232	514	567	1,176
Advanced Math	6,479	7,110	6,691	7,229	7,624
Trigonometry	1,504	1,540	1,593	1,460	1,623
Advanced Algebra	1,550	1,311	1,832	1,465	1,360
Advanced Algebra & Trigonometry	3,754	4,632	4,517	5,245	5,478
Engineering Concepts Curriculum	157	132	242	160	84
Special Interest Math	2,954	3,853	3,615	2,520	1,969
Analytic Geometry	429	724	456	342	322
Probability/Statistics	105	98	100	76	47
Consumer Math	18,301	23,045	22,228	23,057	20,916
Calculus	1,078	1,380	1,546	1,979	2,087
Computer Programming					1,912
Totals	261,524	273,390	262,345	254,674	252,300
Total Student Enrollment (9-12)	370,543	367,502	358,829	349,013	341,165

EPILOGUE

A GIANT STEP IS NEEDED TO IMPROVE STUDENT ACHIEVEMENT IN SCIENCE AND MATHEMATICS

The way to improve student achievement in science and math is to expose the students to the subject matter longer in the presence of better teachers.

There is and has been for some time a big cry in this country about how well students achieve in math and science in other countries and how poorly they achieve in this country. There is evidence that it is probably not just a case of hollering "wolf." And yet, it does have some resemblance to the loud barking dog--the bark may be worse than the bite. The evidence is enough on the side of the criers to know that "wringing hands" is not the best approach to attacking the problem.

This country has been known in the past to set goals of great magnitude and accomplish them through dedication, pride, and expenditure of funds. Examples are the development of prevention for malaria, measles, and polio and placing a human on the moon. If this country wants its youth to "out-achieve" youth in all other countries of the world, it can be accomplished within a decade and a half.

The first order of business is to establish a national goal. And that goal might well be: that in 15 years, students in this country will be achieving in science and mathematics at or above the level of students in any other country in the world. To achieve this goal, a set of strategies must be developed and implemented. Such a goal can be achieved only if it is accepted and supported by government and educators at all levels.

Procedures for Accomplishing Goal:

1. Declare the teaching of science and mathematics essential to national security.
2. Mandate that all science and math teachers, by a certain date, be appropriately certified for their teaching assignments.
3. Require a five-year undergraduate program for science and mathematics teachers, with the fourth and fifth years being paid for with government funds., (Teachers would be obligated to go into teaching for a number of years to "repay" the cost of their fourth and fifth years of schooling.) The fourth year should be the "added" year to the program. During that year, the student should take only pure science and math courses.

The person majoring in science should include several math courses along with the science courses. The person majoring in math would need to take some science courses. It is assumed that some introductory math and science courses would be taken during the first three years of the program.

4. Permit any math or science teacher to return to a state-supported teacher training institution, tuition-free, to further his or her competence in math or science teaching or to change one's certification to science or math.
5. Provide 12 months employment for science and math teachers and require them to be involved in staff development activities, relevant to their assignments, each year.
6. Adopt one of two options by which science and math teachers are paid:
   a. Base salaries on supply and demand, or
   b. Increase present salaries by at least 50%.
7. Require each student to take at least one course in science and one in math each year in grades K-12. Provide students in high school the opportunity to take as many as three math and/or three science courses per year if they so desire.

(While it is not suggested that the federal government mandate the above, if states elect to implement such a plan, financial help from the federal government will be essential. Additional funds will be required for teacher staff development, extended undergraduate programs, facilities and equipment for upgrading laboratories, instructional supplies, and for increasing salaries for math and science teachers.)

It is well known that ignorance in the fields of science and mathematics is costly to a nation and to its individuals. Payment for ignorance may be made in two ways: (1) pay for it through the cost for educating people, or (2) pay for it through having poor services, lower productivity, and lower standard of living, or possibly surrendering to another country which has outpaced the U.S. in science and technology. The preferred payment plan among most Americans is obvious.

Science and math education are in a position atypical of any time during this century. Our nation is confronted with unprecedented problems in science and engineering education. Most severe of these problems is the shortage of qualified science and math teachers in the secondary schools. There is a trend toward allotting less time to science at all levels. The public view of science in the U.S., in general, is negative.

In summary, this country is faced with a task of great magnitude in regard to the problems surrounding science and math education. Does it recognize that task? If so, are we willing to face it head-on, or will we choose to perpetuate mediocrity and hope the problems will go away?

Mr. SIMON. Thank you, Dr. Taylor.

Dr. Thomson, this may seem like a general question. You mentioned the problem of quality in math and science teachers. We face a general problem in teaching, not only with math and science teachers, though it is a more severe problem in that area.

Do you have any reflections on what we as a nation do about this?

Dr. TAYLOR. About the quality of teaching?

Mr. SIMON. Yes, the SAT scores and other tests indicate those going into teaching are not what they ought to be and two studies, one in North Carolina, indicate that many of our best teachers are leaving the teaching profession.

Dr. TAYLOR. It is a problem that can be resolved in my view. It is a matter of, number one, making sure that we have well-prepared teachers. Now, that may sound like an obvious statement, but let me give you an example in another field, in the teaching of English.

We could improve, in my view, English instruction, reading and writing instruction in schools significantly if we would require our English teachers to be more than simply literature majors. What we need are tougher requirements in there for our English teachers that are entering the teaching field to be better prepared in writing, composition, and in language, as well as in literature.

That is just one example. I think the fields of science and math education have been covered adequately. We simply do not have, in those fields, a 100-percent adequately prepared teaching force.

The second step I think we need to take is one that the colleges and universities are already taking, and I mentioned that earlier, Mr. Chairman, there is a revolution going on in college admission requirements.

One of the reasons—the central reason—that foreign language instruction has fallen off so dramatically, the reason that we have very few students taking foreign languages, can be simply, can be answered simply by looking at the decline in the requirements for foreign language to enter colleges and universities.

There is a very direct relationship, as you pointed out from time to time over the last year in your hearings. One of the assured ways of increasing the foreign language instruction in secondary schools is simply for universities to require 2 years or 3 years of foreign language for entrance.

So that would assist greatly and we have to recognize that college entrance requirements play a very significant role, have a very strong impact on secondary schools.

Then it comes down finally, I think, to a matter of providing adequate salaries. Personally, I don't believe the Federal Government should get involved in providing salaries at all, but I think there is leadership that is important here. I think the platform is important to point out to the Nation that unless we have adequately prepared teachers, we are not going to get the best people in the field.

Finally, I am very pleased to see the public interested in quality again. I was superintendent of schools in your home State, Evanston, Ill., from 1968 to 1974. One of the finest high schools in the Nation.

And yet, from the time I went there in 1968 for about 4 years, to 1972, I didn't hear anyone ask me about reading scores or SAT scores. I did not hear anyone ask me about quality or about maintaining achievement.

There were other items on the agenda, the national agenda, as you know, having to do with access, lowering dropout rates, and all the others. And we have an unfortunate tendency as Americans to swing back and forth and too great the pendulum too widely.

Now, as a citizen might say to an educator, why didn't you stand up and speak for good education in those days, why didn't you insist on maintaining the highest standards?

And I say, perhaps we should, perhaps as a profession, we made a serious error. We certainly support the higher standards that are now being demanded, and to some degree, being achieved.

Our achievement scores are up, as well as our SAT scores. I think we are getting there again.

Mr. SIMON. Thank you very much.

Mr. Boehm, you mentioned this excellent program at Southwest High School, and let me add my commendation to Monsanto. I just mentioned this yesterday on a television program recorded for national distribution this next weekend, about the Monsanto program with Washington University, which is a great tie-in that I think will benefit both Monsanto and Washington University.

What you are doing at Southwest High School is a great thing because you have the right kind of leadership in your corporation.

How do we get other corporations to do the same?

Mr. BOEHM. Well, Mr. Chairman, I spoke at a national association for industry education conference back last year in Columbus, Ohio, and that is an association geared toward getting industry and education together.

We are the people that require the educated students and the education people or the people that produce the education students, so it is a very dire need that we have this kind of cooperation.

I think in general, industry, and I mentioned North Carolina, has a similar program and I know a number of other States have this, the word needs to get out that those things are being done, this is one reason that our company has said, "Elmer, go to Washington and tell people about what is going on," because the communication needs to be told to other people, that it is worthwhile.

It is voluntary, it does not require a major commitment in terms of dollars on the part of the company, it does require a commitment, though. We do these things in so many other areas, and yet science and math are so important to us, and so important to our Nation, that if we can encourage other industries, and I know many of them are involved in this, to do the similar programs that we are doing in St. Louis, it is going to help the entire education system.

Mr. SIMON. Thank you very much.

Mr. Tucker, in your testimony, you are a little more sanguine, maybe than I am about the situation. No. 1, don't you face the reality if the economy of this country improves, you are going to be faced with the same kinds of problems you had just a few years ago?

Mr. TUCKER. Well, sir——

Mr. SIMON. And No. 2, the second part of that, doesn't the fact that you have just downgraded your manuals from eighth-grade to sixth-grade level also indicate that there continues to be a problem?

Mr. TUCKER. To the first point, sir, on economics, there is certainly no gain saying the situation in the economy has something to do with our success in recruiting. But we do have some other things going for us that we did not have going for us a few years ago.

We have a competitive pay scale which we did not have then; we have a much more effective advertising program which has gotten the word out more.

We have gotten a better package of enlistment and reenlistment bonuses, particularly reenlistment bonuses, to keep the people we have already trained, the people we really want.

And then we have gotten an educational program such as the Army college fund, which is a VEAP program, you may be familiar with it, that is veterans educational assistance program, where the kicker for those people who score well on our entrance test and who are willing to enter certain critical fields, so while the economy has something to do with it, we are not wholly pessimistic that we cannot remain competitive.

That is certainly the commitment of this administration. On the question of downgrading, sir, I am not familiar with programs to downgrade our reading material to sixth-grade level; I would be interested in seeing anything like that. I do know that we are moving to bring our reading grade level down to the ninth-grade level, which is approximately the national average.

Many of our manuals are written in 13th-grade level, 12th-grade level, 10th-grade level, they are also in formats that are not readily accessible to people, we have a number of programs going on that are attached to this reading-grade-level change, making programable text so that it is easier for people to find something in our manuals.

If you could see the manual for the Abrams tank, it is about three manuals this high, sir. The programable text is very readily accessible and very easy to read with a lot of illustrations. The idea is to make the information accessible so that we can maintain the equipment.

Mr. SIMON. Dr. Flowers, you made two suggestions, one of which I am going to ask you to follow through on and does not require comment right now. One I want to read into the record by itself, because I think this is an excellent suggestion that would be helpful, not only in the math and science areas, but some other areas:

> We encourage you to consider the former National Science Foundation model of summer institutes for elementary and secondary school teachers as a viable and much-needed program to upgrade the skills of teachers in the classroom.

I think that is an excellent suggestion, one of the finest things Federal Government has done. You have mentioned one other possibility and I am just going to personally ask you to reflect on this and send me and the other members of this committee a letter. You talked about a Comprehensive Educational Development Act that could not only help in the areas of math and science, but in some other areas also.

If I may give you an assignment here——

Dr. **Flowers**. All right, I would be glad to take home some homework.

Mr. **Simon**. We thank you for your testimony.

One final question, then I will yield to my colleagues.

Dr. Taylor, I was interested, as I went through your statement, you say, "Factors that continue to hamper the advancement of science and math education," and you list one of them, No. 3, as the back-to-basics movement, that hurts science and math.

Now, my assumption would be that it would help science and math.

Dr. **Taylor**. Sir, the main reason for that statement as it is, in most cases, in the minds of people, science is not one of the basics. When we talk about basics, it is mainly the three R's that we have become accustomed to in the past, language arts, reading, and mathematics.

So that is what is meant by saying that it hurts science. The emphasis by teachers is going to be placed on those subjects which are in vogue, so to speak, and more pressures are being put upon them to have their students to do well in those subjects.

Mr. **Simon**. But if the student can read well, obviously he can master science texts much more readily, but your experience is that the back-to-basics movement, in fact, has been a detriment to science education?

Dr. **Taylor**. We feel that it is hurting, yes, sir. But I agree with the statement that you made about being a good reader helps a person be a better science student, yes.

Mr. **Simon**. Mr. Kildee.

Mr. **Kildee**. Thank you, Mr. Chairman, and I thank the witnesses for their testimony. I apologize for being tardy, but I was at another hearing of the Interior Committee.

I want to preface my questions, by saying that I am very open-minded about and very interested in these bills. Perhaps I will be playing the role of the devil's advocate today because as these bills proceed through congressional consideration many questions will be asked of us.

Would not the various components in these bills, such as summer employment for math and science teachers and loan forgiveness, for example, in effect, be creating a differential pay for those teachers? I wonder does that not say, then, that the language arts and the social sciences are of less importance in our society?

Mr. **Thomson**. I would be glad to respond to that. I don't believe that offering summer employment to a math or science teacher does say that an English teacher is of less value to our society.

I do believe that if school systems pay a differential salary to a math or science teacher, if you pay a bonus, then I think it does make that statement and our association is opposed to differential pay for math or science teachers by the school district.

I think what we are saying, when employment is offered to math and science teachers on a tax-deferral basis or whatever, we are saying that the supply and demand requires that if we are going to have science teachers in our schools, and have them paid at the same rate as other teachers, that there has to be some kind of incentive plan or other sources of income, in this case, business, technological and scientific businesses could do that job.

I think that is fair. I think that is fair. I also believe that there is general recognition. I also believe that kind of incentive program that does not come out of the local school district's budget is simply a recognition of that fact, that we do live in that kind of society and that we have to provide an adequate teacher force to take care of that.

Mr. KILDEE. Would anyone else care to comment on that?

Dr. Taylor?

Dr. TAYLOR. I don't think that to offer an incentive, whether it be pay or working conditions or what have you, is saying that science is more important than language arts and what have you.

I think it is saying that there is a greater demand for instructional people in those areas. That is basically what it means to me.

Mr. KILDEE. You are talking about the employment marketplace, the supply and demand of personnel where needed.

Dr. TAYLOR. Yes.

Dr. FLOWERS. I think this is an opportunity to keep those people updated, too, and many other teachers are going back to school and are looking for opportunities for institutes and so on of a similar nature, but we are talking about putting these people on a job to learn that very thing.

It is a good model for other areas also.

Dr. TAYLOR. The situation is similar in medical schools. In your colleges and universities, to get top-rated physicians into those schools, they pay them a much greater salary than many of the other staff members.

I might also point out that there are opportunities for teachers in other fields to make quite substantial summer incomes. For example, many physical education teachers will say that the swim coach, for example, will run a major swimming program all summer and have a good income from that.

There are other examples. The music teacher may run a summer music camp and so forth, so it would not be simply the science teachers that have this opportunity, it would be the science teachers having an opportunity to work with this tax rebate program.

Mr. KILDEE. When I taught, language teachers were always considered lucky if they got a job helping to painting the school during the summertime.

Dr. TAYLOR. By mention, the foreign language teachers can take trips to Europe and pay that way, too, so there are other ways.

Mr. KILDEE. I wonder if perhaps the major problem is the manner in which we compensate a variety of people in our society for the services they render, including teachers. Have we, as a society, faced the fact that teachers in all fields are extremely important? One of my children's teachers came to my office one day asking me for a job on the Hill, because she found it very difficult to continue teaching with the pay scale in Fairfax County.

Now, Fairfax County is not the lowest paid area around here, but when I look at the pay scale out there, I frankly do not know how teachers can afford to live in Fairfax County.

Maybe we have to address ourselves also to the problems of how society evaluates and values the role of teachers in general.

I think maybe that is something that we have not quite faced up to.

Mr. SIMON. You might broaden that question to education in general, not simply teachers.

Mr. KILDEE. That is certainly a more appropriate way of stating it.

Teachers across the country have to buy their groceries at the same stores from which someone like me buys, who makes $60,000 a year while they are making perhaps a third of that amount. There is, I think, perhaps a certain unfairness in the way we evaluate and value various professions in our society. I think we should consider that along with this particular and special need that we are addressing ourselves to.

For example, it is always strategically good in legislation to use the word "defense," maybe even more so now than it was several years ago when we had the National Defense Education Act, because of the shift of dollars toward that area of our budget.

I am not sure how well-trained Phillip Habib, for example, is in math or science, but I suspect he is quite well trained in the language arts and the social sciences. We need more Phillip Habibs around, don't we?

I think your testimony has been very helpful. While we are addressing ourselves to this real problem, however, maybe we can also set upon a more general problem in our society.

Thank you, Mr. Chairman.

Mr. SIMON. We thank all of you for your testimony, your presentations, here today.

The subcommittee hearing stands adjourned.

[Whereupon, at 11:54 a.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

PREPARED STATEMENT OF NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

The Shortage of Mathematics Teachers

The National Council of Teachers of Mathematics (NCTM) is a 60 000-member professional association interested in the improvement of mathematics education at all levels. The Board of Directors of NCTM and its affiliates thank the Elementary, Secondary and Vocational Education Subcommittee and the Postsecondary Subcommittee of the U.S. House of Representatives Educational and Labor Committee for conducting these hearings and permitting the Council to present its perspective.

The testimony of the Council is in response to the following set of questions:

- What is the extent of the mathematics teacher shortage?
- What is the impact of a shortage of mathematics teachers?
- What is being done to reduce the mathematics teacher shortage?
- What is the federal role in reducing the mathematics teacher shortage?

We appreciate the difficulties posed by teacher shortages in other fields such as science and engineering; however, we are restricting our comments to the teacher shortage in mathematics.

This testimony includes statistics on the teacher shortage as well as supporting information in the Appendix. NCTM is willing to provide more information on request.

The Extent of the Mathematics Teacher Shortage

A severe shortage of mathematics teachers exists in the United States. In the fall of 1980 the supply of mathematics teachers was only 78 percent of the demand, and the outlook for reversing this shortfall is not good.

Some recent statistics will highlight the problem:

- In a 1981 survey 43 of the 45 reporting states indicated a shortage or critical shortage of secondary school mathematics teachers ("National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers," 1981).

- Since 1972 there has been a 77 percent decline in the number of secondary school mathematics teachers prepared in 600 teacher-training programs nationwide (Education Week, March 1982).

- If mathematics teachers continue to abandon the profession at the current rate, U.S. schools will lose more than one-third of all their mathematics teachers in the next ten years. When the new surge of elementary school children reaches high school the supply of mathematics teachers will be severely depleted (American School Board Journal, September 1982).

- California: Of the more than 400 000 students in California's public four-year institutions in the spring of 1982, only 97 were preparing to be secondary mathematics teachers (Phi Delta Kappan, September 1982).

- New York: The nation's second-most populous state had only 32 college graduates planning to teach junior or senior high school mathematics in 1982 (Christian Science Monitor, 12 July 1982).

- Texas: Only 20 new mathematics teachers graduated in the state in 1982, and of these only 7 went into teaching (Mesquite Daily News, 11 May 1982).

- Connecticut: Last year the state lost 100 mathematics teachers through retirement or job shifts while only 38 people were certified to teach mathematics (Hartford Courant, 30 July 1982).

- Iowa: The number of graduates preparing to teach mathematics declined from 234 in 1970 to 60 in 1979 while the number of vacancies in that period fluctuated between 200 and 250 each year (School Science and Mathematics, January 1982).

- Missouri: Only about 40 of the 80 prospective mathematics teachers who will graduate from Missouri's teaching institutions are expected to be teaching the following fall, although at least 200 vacancies are expected in the state (Kansas City Times, 21 May 1982).

- New Jersey: The New Jersey State Department of Education has declared an emergency shortage of mathematics teachers in 17 of New Jersey's 21 counties. This designation permits districts to use unlicensed teachers--some without bachelor's degrees--to teach the subject. Only 30 new mathematics teachers were graduated from the state colleges in 1982 (New Jersey Star-Ledger, 13 September 1982).

- North Carolina: In 1979-80 only 55 percent of the mathematics teachers in the state were certified to teach mathematics (Mathematics Teacher, December 1981).

Many able teachers are being drawn to more lucrative fields. Only about half of those students prepared to teach mathematics ever enter the classroom. Some potential teaching candidates are not even seeking teaching credentials in favor of other college majors such as computer science. Sadly, principals last year felt that half the mathematics teachers they hired were not qualified to teach mathematics but were hired on an emergency basis because they could not find qualified teachers.

Impact of the Shortage of Mathematics Teachers

The shortage of mathematics teachers affects other parts of society as well as the schools. Our technological work force begins with a good foundation of high school mathematics. Let's briefly examine a few of the implications of a shortage of mathematics teachers.

First, the shortage discourages current secondary students from pursuing careers in mathematics teaching. Only dynamic, well-informed teachers are likely to serve as models to draw capable new teachers into the field and at the same time attract students to study mathematics in high school. Potential prospective teachers as well as students who pursue science-related studies in college are generally drawn from the pool of students in high school who have studied mathematics in the secondary school's college-preparatory curriculum. Yet between 1972 and 1980 there was a 6 percent drop in the number of seniors enrolled in this curriculum. Perhaps in a subtle way we are already seeing the impact of this shortage.

Second, the shortage discourages students from pursuing their study of mathematics, which in turn limits their choice of career options to the narrowing range of nontechnological professions at a time when demand is high in technological fields. For example, the Department of Defense reports difficulty in recruiting and retraining civilian and military engineers. The Air Force reports a shortage of 1100 engineers. Fewer armed service personnel are even qualified to be trained to operate increasingly sophisticated military hardware.

Third, these conditions make it difficult for states to increase the number of mathematics courses required for graduation. Currently only one-third of the nation's 17 000 school districts require graduates to take more than one year of mathematics or science, and seven states require no mathematics. Even now our standards are below those of some of the other major industrialized nations, such as Japan and the Soviet Union. The U.S. ranks third behind those two countries in the proportion of engineering graduates in the population. The opportunity to reverse these discouraging trends begins with a solid foundation of high school mathematics.

A Sampling of Options for Increasing the Number of Certified Mathematics Teachers

A number of strategies are being explored to deal with the shortage of mathematics teachers. The effectiveness of these efforts cannot be evaluated, since many of them have been inaugurated only in the past few months.

1. Alabama and Kentucky have approved undergraduate loan programs to students pursuing a teaching degree in mathematics. These loans cover tuition and some other expenses. In each state, portions of the loan do not need to be paid off if the recipient teaches in the state for several years. Similar programs are being considered in North Carolina, New York, and Mississippi.

2. Several school systems, such as those in Philadelphia, Houston, Fairfax County in Virginia and Palm Beach County in Florida are screening experienced teachers for entrance into

programs that lead to middle school or secondary school certification in mathematics. The eligibility for these programs involves favorable teaching experience in the school system, an aptitude for mathematics, and often some successful completion of college-level mathematics courses. States that have a middle school certification hope that once newly certified teachers at this level complete their training, they will begin teaching at this level; then fully certified secondary school teachers can move on to the secondary school. Other states are considering inaugurating a middle school certification that is not as rigorous as secondary certification. This retraining model is likely to be used by large school systems. Teachers who earn additional credits in their retraining may also earn more money on the salary schedules.

3. In some cities special financial incentives are available to mathematics teachers. In Houston, Texas, mathematics teachers can earn $800 a year extra (soon to be $2000). In Oklahoma City, certified mathematics teachers new to the system receive a $500 bonus, and all mathematics teachers are eligible to receive an extra $100 for each mathematics course taught each year. Certified mathematics teachers who are hired in Richmond, Virginia, receive a one-time $2000 bonus for signing--$1500 to be paid at the end of the first year and $500 at the end of the second year.

Cooperative efforts between some school systems and local industries to deal with the shortage of mathematics teachers are now being considered, however, the current economic conditions suggest that these efforts will not become widespread. It also does not appear promising that salaries of teachers will be increased substantially to make the entire profession more financially rewarding and attractive.

Why Is the Shortage of Mathematics Teachers a Federal Concern?

Our national economy is affected by both the shortage of skilled teachers and a shortage of skilled workers. Each state and community feels the effect of these shortages either directly or indirectly through the lowering of national productivity, a shortage of high-tech materials, or an inability of individuals to master the skills needed to improve production through high technology.

As a result, our entire society is influenced by our nation's inability to maximize our productive capability and to compete successfully for new domestic and foreign markets. This shortage has a pervasive impact on the entire society. Technicians are not receiving adequate basic instruction in mathematics so that they can continue their technical training. Individuals in need of technical skills are left without the expertise they need to advance themselves in an age of computers. Potential scientists and engineers needed for research and development efforts are not encouraged to pursue the study of mathematics.

The significance of the shortage extends beyond state boundaries. Creative solutions require a national involvement. If one state is solving "its" mathematics teacher shortage (and by extension its skilled worker shortage), the nation benefits, but it is not enough. All states need to do well in this area. With our mobile population, the efforts of a few resourceful states should not be relied on to solve the problem of the shortage. The federal government should begin to offer leadership and to take action to ensure that all students have the benefit of mathematics instruction from a qualified and certified teacher. These efforts can be made through existing governmental units.

Summary

The Board of Directors of the National Council of Teachers of Mathematics is concerned about the shortage of mathematics teachers. This shortage is part of a larger societal problem of not having a sufficient work force of individuals with mathematics skills. Increasing the number of certified mathematics teachers seems to be a reasonable first step in addressing the needs of our students and in turn the needs of industries in our economy.

The federal government must offer leadership and take action to eliminate the shortage of certified mathematics teachers. The few states and cities that have begun programs to bring skilled teachers to their students should not be viewed as the major component of a national initiative to attract and train mathematics teachers for the remainder of the states. The federal government needs to design a program that will allow all states and all students equal access to the mathematical training they need to be productive in our technological society.

Appendix

MATHEMATICS TEACHER SHORTAGE, An NCTM Fact Sheet..................1

Teacher Supply/Demand 1982, A Report Based Upon an Opinion Survey of Teacher Placement Officers, Association for School, College and University Staffing (ASCUS)..3

Teacher Supply and Demand in Public Schools, 1980-81, NEA Research Memo: Table 1.--Supply and Demand for Beginning Teachers in Public Schools by Type of Assignment, Fall 1980..4

Estimated Supply of Secondary Biology, Chemistry, Physics, General Science, Earth Science, and Mathematics Teachers by State in 1980 (*Education Week*, 23 November 1981)............5

What to Do When Your Science and Math Teachers Abandon Their Classrooms (*American School Board Journal*, September 1982)..6

This Bold Incentive Pay Plan Pits Capitalism against Teacher Shortages (*American School Board Journal*, September 1982)......9

U.S. Tackling Crisis in Science and Math (*New York Times*, 10 August 1982)..11

State Aims to Fill Math, Science Gap (New Jersey *Star-Ledger*, 13 September 1982)..13

Wanted: Math, Science Teachers and Students (syndicated column of James Kilpatrick, 17 August 1982)...................15

Math and Science Are Dying (*Kansas City Times*, 2 June 1982)......16

NATIONAL COUNCIL OF
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MATHEMATICS TEACHER SHORTAGE
An NCTM Fact Sheet

National Perspective

1. Mathematics teaching has the severest shortages of any subject area in 1981. (Teacher Supply and Demand 1982, Association of School, College and University Staffing.)

2. Since 1972 there has been a 77 percent decline in the number of secondary-level mathematics teachers prepared in 600 teacher training programs nationwide. Among newly employed science and mathematics teachers, 50.2 percent were judged by principals to be unqualified to teach in those fields, but had been employed on an emergency basis because school officials could not find qualified teachers. In the Pacific States the ratings of unqualified personnel jumps to 84% by the principals. (Education Week, 31 March 1982.)

3. Only 55% of the graduates prepared to teach mathematics actually entered the teaching profession. Almost five times more science and mathematics teachers left teaching in 1980 for employment in nonteaching jobs than left due to retirement. If the present exodus of qualified science and mathematics teachers from secondary schools continues, the nation will have a net loss of 35% by 1992. The declines in qualified science and mathematics teachers have already exceeded enrollment declines by a factor of three. (Testimony of Sarah E. Klein, President of the National Science Teachers Association, before the Committee on Labor and Human Resources of the United States Senate, 1982.)

4. For fall 1980 the supply of mathematics teachers was only 78% of the demand. (Teacher Supply and Demand in Public Schools, 1980-81, NEA Research Memo.)

5. 43 of the 45 reporting states indicated a shortage or critical shortage of secondary mathematics teachers in 1981. ("National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers" by Trevor G. Howe and Jack A. Gerlovich. Prepared for the High School Chemistry Teacher Conference, Columbia, Missouri, 6 November 1981.)

6. "Alleviating the math-teacher shortage is one of the most immediate and pressing tasks facing colleges and school systems." (U. S. News and World Report, 15 February 1982.)

7. "A shortage of mathematics and science teachers hampers the ability of the schools to provide science and mathematics instruction." (Science & Engineering Education for the 1980's & Beyond, National Science Foundation and Department of Education, October 1980.)

Selected States

1. North Carolina: In 1979-80 only 55% of the mathematics teachers in the state were certified to teach mathematics. (Mathematics Teacher, December 1981.)

2. Missouri: Only about 40 of the 80 prospective mathematics teachers who will graduate from Missouri's teaching institutions are expected to be teaching the following fall, although at least 200 vacancies are expected in the state. (Kansas City Times, 21 May 1982.) There was a 43% increase in the issuance of emergency certification in 1979 vs. 1978. (Mathematics Teacher, March 1981.)

3. New York: The nation's second-most populous state, had only 32 college graduates planning to teach junior or senior high school mathematics in 1982. New Hampshire: Only one college graduate in the state in 1982 is planning on a career in mathematics teaching. (Christian Science Monitor, 12 July 1982.)

4. California: Of the more than 400 000 students in California's public four-year institutions in the spring of 1982, only 97 were preparing to be secondary mathematics teachers. (Phi Delta Kappan, September 1982.)

5. Texas: Only 20 new mathematics teachers graduated in the state in 1982, and only 7 went into teaching. (Mesquite Daily News, 11 May 1982.)

6. Maryland: A survey by the State Department of Education at the end of the 1979-80 school year estimated that 30,000 secondary students received their mathematics instruction from more than 400 teachers who were not certified to teach secondary mathematics. (School, March/April 1981.) In 1982 only 17 new mathematics teachers graduated in the state and 8 went into teaching. (Clarence Miller, Maryland State Department of Education, June 1982.)

7. Connecticut: Last year the state lost 100 mathematics teachers through retirement or job shifts while only 28 mathematics teachers graduated from the 14 state institutions. (Steve Leinwand, Connecticut Department of Education, September 1982.)

8. New Jersey: The State Department of Education has declared an emergency shortage of mathematics teachers in 17 of New Jersey's 21 counties. This emergency designation permits districts to use unlicensed teachers--some without bachelor's degrees--to teach the subject. (Star-Ledger, 13 September 1982.)

9. Iowa: The number of graduates prepared to teach mathematics declined from 234 in 1970 to 60 (-74%) in 1979. The number of vacancies in that period fluctuated between 200 and 250 each year. Shortages are most severe in smaller school districts. (School Science and Mathematics, January 1982.)

10. Mississippi: State Superintendent of Education Charles Holladay reported that state institutions are not even close to providing the 400 to 500 mathematics teachers that will be needed this year. (Jackson Daily News, 9 July 1982.)

Some Solutions

1. Nationally: John Glenn (D-Ohio) and Dave McCurdy (D-Oklahoma) have introduced a "Precollege Mathematics and Science Teacher Assistance Act" which amends the Title IV of the Higher Education Act of 1965 to provide direct loans (7% interest) to college students preparing to be elementary and secondary mathematics and science teachers. Their "Precollege Mathematics and Science Education Act" amends the Internal Revenue Code to allow a credit for high technology employers who hire precollege mathematics and science teachers for the summer. A credit is also provided to firms that allow full-time employees the hours away from work to teach mathematics and science in public schools. (Both bills are being considered by the House Science and Technology Committee, July 1982.)

2. Alabama: Undergraduates who seek mathematics teaching certification are eligible for loans for tuition, books, room and board for each year of full-time study. For each year of teaching experience, one year of the scholarship will be forgiven. Teachers with six hours of mathematics (college algebra or higher level courses) are eligible for a permit to teach vocational and general mathematics at the seventh and eighth grade levels. The certificate is renewable upon entry into a state approved program leading to full certification. (William Berryman, Alabama State Department of Education, July 1982.)

3. Kentucky: Undergraduates who seek mathematics teaching certification are eligible to receive $2500 loans beginning with their sophomore year. A year of the loan will be forgiven for each year of teaching. Certified teachers in other fields who attend summer school to become certified to teach mathematics will qualify for up to one-third of the loan amount. (Lydia Sledge, Kentucky Department of Education, July 1982.)

4. California: 15 million dollars has been set aside for this fiscal year for upgrading skills of mathematics and science teachers in grades K-12 through offerings of 15 regional centers around the state. (Joe Hoffman, California State Department of Education, September 1982.)

5. Houston, Texas: Critical staff stipends for mathematics teachers are $800 a year and may soon be increased to $2000. As part of Project Search, tuition and book costs as well as $250 per course were paid to selected experienced teachers who completed a summer program of four three-hour courses with a grade of B or better. Through this process, teachers were able to earn the 15 credit hours needed for temporary middle school certification then full certification with 18 credit hours. (Mira Baptiste, Houston Independent School District, September 1982.)

6. Oklahoma City, Oklahoma: Certified mathematics teachers new to the system receive a $500 bonus. All certified mathematics teachers are eligible to receive an extra $100 per course taught each year. (Carl Buble, Oklahoma City Schools, July 1982.)

7. Richmond, Virginia: Certified mathematics teachers who are hired by the Richmond schools receive a $2000 bonus for signing--$1500 for the first year and $500 the second year. Teachers who leave before two years must pay back a portion of the bonus. (Jerry Owens, Richmond Public Schools, August 1982.)

8. Philadelphia, Pennsylvania: Selected teachers will participate in a 3-year program resulting in certification and will be guaranteed jobs teaching mathematics. (Philadelphia Inquirer, 9 February 1982.) Vacancies in the middle and junior high school level are being filled with people who have no background in secondary school mathematics. (Pennsylvania Council of Teachers of Mathematics Newsletter, March 1981.)

9. Dallas, Texas: $500 000 has been allotted for tuition, books and transportation for teachers who wish to upgrade their skills in mathematics and for those who wish to gain certification in mathematics. (Mary Lester, Dallas Public Schools, July 1982.)

10. Fairfax County, Virginia: Teachers who have been in the school system for four years and who wish to earn mathematics teaching certification (27 hours) may enroll in a series of courses through Northern Virginia Community College and a local four-year university. The tuition is paid but teachers must teach in the system for three years after gaining certification or repay tuition costs. (Sylvia Auton, Fairfax County Schools, July 1982.)

11. Palm Beach County, Florida: Teachers not certified to teach middle or junior high school mathematics can gain certification by taking a sequence of three state certified courses. Tuition is free to teachers. (Ruth Bower, Palm Beach County Public Schools, July 1982.)

M/9/82/2385A

From Teacher Supply/Demand 1982

RELATIVE DEMAND BY TEACHING AREA AND YEAR
Continental United States

Based upon a Survey of Teacher Placement Officers

	1982	1981	1980	1979	1978	1976
Teaching fields with considerable teacher shortage....(5.00 - 4.25):						
Mathematics	4.81	4.79	4.80	4.68	4.40	3.86
Science-Physics	4.41	4.56	4.28	4.36	3.91	4.04
Industrial Arts	4.36	4.72	4.77	4.68	4.65	4.22
Vocational Agriculture	4.36	4.46	4.73	4.67	4.69	4.06
Teaching fields with slight teacher shortage..........(4.24 - 3.45):						
Special Education-LD	4.20	4.47	4.48	4.50	4.45	4.00
Bilingual Education	4.13	4.10	4.21	4.32	--	--
Science-Chemistry	4.13	4.42	4.18	4.09	3.97	3.72
Special Education-PSA	3.98	4.22	4.36	4.22	3.96	3.42
Speech Path./Audiology	3.95	4.27	4.17	3.83	3.83	3.68
Special Education-Multi.Handicapped	3.93	4.13	3.87	3.24	--	--
Science-Earth	3.89	4.08	3.64	3.82	3.50	3.44
Data Processing	3.86	--	--	--	--	--
Special Education-MR	3.84	4.14	4.23	4.39	3.52	2.87
Special Education-Gifted	3.81	4.10	4.33	4.56	3.95	3.85
Special Education-Reading	3.73	4.21	4.23	4.27	4.09	3.96
Science-Biology	3.66	3.98	3.50	3.49	3.11	2.97
School Psychologist	3.56	3.70	3.87	3.43	3.68	3.09
Business	3.47	3.50	3.80	3.65	3.52	3.10
Teaching fields with balanced supply and demand.......(3.44 - 2.65):						
Music-Instrumental	3.28	3.33	3.65	3.33	3.30	3.03
English	3.21	3.37	3.51	2.78	2.30	2.05
Library Science	3.12	3.31	3.58	4.26	--	--
Music-Vocal	2.95	3.06	3.32	2.97	3.03	3.00
Counselor-Secondary	2.79	3.13	3.76	3.03	3.31	2.69
Driver's Education	2.77	2.87	2.98	3.06	2.63	2.44
Speech	2.76	2.65	2.50	2.47	2.48	2.46
Counselor-Elementary	2.72	3.05	3.38	2.96	3.00	3.15
Language, Mod.-Spanish	2.68	2.95	3.34	2.88	2.84	2.47
Teaching fields with slight surplus of teachers.......(2.64 - 1.85):						
Journalism	2.61	2.77	2.98	2.50	2.54	2.86
Language, Mod.-French	2.49	2.58	2.68	2.49	2.15	2.15
Language, Mod.-German	2.48	2.58	2.70	2.17	2.28	2.03
Home Economics	2.43	2.54	2.85	2.67	2.37	2.62
Social Worker (School)	2.34	--	--	--	--	--
Elementary-Intermediate	2.26	2.56	2.84	2.33	1.97	1.90
Social Science	2.11	2.05	1.98	1.83	1.51	1.51
Elementary-Primary	2.02	2.24	2.77	2.19	1.84	1.78
Health Education	1.90	2.24	2.17	2.16	2.38	2.27
Teaching field with considerable surplus of teachers..(1.84 - 1.00):						
Art	1.84	2.00	2.45	2.06	1.72	2.14
Physical Education	1.72	1.80	1.82	1.67	1.86	1.74

5 = Greatest Demand, 1 = Least Demand

ASCUS Supply/Demand
January, 1982

James N. Akin
Kansas State University

Teacher Supply and Demand in Public Schools, 1980-81.
NEA Research Memo

TABLE 1.—SUPPLY OF AND DEMAND FOR BEGINNING TEACHERS IN PUBLIC SCHOOLS BY TYPE OF ASSIGNMENT, FALL 1980

Assignment area	Estimated number completing preparation to teach	Estimated supply	Estimated demand	Supply minus demand	Supply as percent of demand	Number of states reporting in 1979: Great difficulty in filling positions	Number of states reporting in 1979: General employment of persons with substandard qualifications	Number of nine regions in which placement officers report shortages in 1980
1	2	3	4	5	6	7	8	9
ELEMENTARY TOTALS	72,600	60,525	40,825	19,700	148.3	. . .	. . .	. . .
Regular instruction	61,575	52,025	32,575	19,475	167.3	1	1	0
Special education	11,825	8,500	8,250	250	103.0	27	16	7
SECONDARY TOTALS	81,625	58,725	30,600	28,125	191.9	. . .	. . .	. . .
Agriculture	1,200	850	525	325	161.9	18	7	6
Art	4,575	3,275	725	2,550	451.7	1	0	0
Business education	4,650	3,325	1,475	1,850	225.4	7	3	1
Distributive education	375	275	175	100	157.1	9	1	*a*
English language arts (total)	10,200	7,300	4,500	2,800	162.2	3	1	1
Foreign languages (total)	2,550	1,825	950	875	192.1	3	3	1
Home economics	3,600	2,575	1,150	1,425	223.9	2	0	0
Industrial arts	2,775	1,975	975	1,000	202.6	27	12	8
Mathematics	3,150	2,250	2,875	-625	78.3	30	15	9
Music	7,275	5,200	2,025	3,175	256.8	2	1	2[b]
Physical and health education—boys	9,450	6,750	1,275	5,475	529.4	1	0	0
Physical and health education—girls	8,325	5,950	1,175	4,775	506.4	0	0	0
Natural and physical sciences (total)	5,175	3,700	2,550	1,150	145.1	18	12	8[b]
Social sciences (total)	10,200	7,300	2,275	5,025	320.9	1	0	0
Trade, industrial, vocational, technical	1,350	975	1,650	-475	59.1	12	5	*a*
Other secondary subjects	150	100	1,350	-1,250	7.4	*a*	*a*	*a*
Special education	6,625	5,100	4,950	150	103.0	32	20	7
TOTAL: Elementary and Secondary	154,225	119,250	71,425	47,825	215.2	. . .	. . .	. . .

[a] Not included in survey.

[b] *Music*—citations were for instrumental music but not for vocal music. *Natural and physical sciences*—number of citations were for the following specific subjects: Biology (3), Chemistry (7), Earth Science (4), Physics (8), and General Science (5). *Special education*—number of citations were for the following specific areas: Emotionally disturbed (6), Gifted (4), Learning disabled (7), Mentally retarded (5), Multiple handicapped (3), Reading (6), Speech and Hearing (5), and Other (3).

Definitions of Terms Used in This Study

Quality Criterion Estimate: The number of teachers needed to attain a minimum level of quality in public schools this year.

Adjusted Trend Criterion Estimate: The number of teaching positions that will be filled.

Beginning Teacher: A person entering active employment as a full-time teacher for the first time.

Reentering Teacher: A person reentering active status who was not employed as a full-time teacher during the preceding school year.

New Teacher: A person entering or reentering active status who was not employed as a full-time teacher during the preceding school year. (The demand for new teachers is the sum of the demand for beginning and the demand for reentering teachers.)

DATABANK

Estimated Supply of Secondary Biology, Chemistry, Physics, General Science, Earth Science, and Mathematics Teachers by State in 1980

State	Biology	Chemistry	Physics	General Science	Earth Science	Math
Alabama	slight surplus	adequate	critical shortage	adequate	shortage	no response
Alaska	surplus	surplus	surplus	surplus	surplus	surplus
Arizona	no response	no response	no response	no response	no response	no response
Arkansas	adequate	shortage	shortage	adequate	adequate	shortage
California	slight surplus	slight surplus	shortage	adequate	shortage	slight surplus
Colorado	adequate	adequate	adequate	adequate	adequate	adequate
Connecticut	adequate	adequate	shortage	adequate	adequate	shortage
Delaware	adequate	adequate	adequate	adequate	adequate	adequate
District of Columbia	adequate	adequate	shortage	slight surplus	adequate	shortage
Florida	adequate	critical shortage	critical shortage	shortage	critical shortage	shortage
Georgia	surplus	surplus	surplus	surplus	surplus	surplus
Hawaii	slight surplus	shortage	shortage	adequate	shortage	adequate
Idaho	surplus	shortage	shortage	adequate	shortage	shortage
Illinois	adequate	critical shortage	critical shortage	shortage	shortage	critical shortage
Indiana	critical shortage	critical shortage	critical shortage	critical shortage	critical shortage	critical shortage
Iowa	slight surplus	critical shortage	critical shortage	adequate	shortage	critical shortage
Kansas	slight surplus	shortage	shortage	shortage	shortage	shortage
Kentucky	adequate	shortage	critical shortage	adequate	shortage	critical shortage
Louisiana	adequate	shortage	critical shortage	adequate	shortage	shortage
Maine	adequate	adequate	adequate	adequate	adequate	shortage
Maryland	adequate	shortage	shortage	shortage	shortage	shortage
Massachusetts	surplus	surplus	surplus	surplus	surplus	surplus
Michigan	adequate	shortage	shortage	adequate	adequate	shortage
Minnesota	slight surplus	adequate	shortage	adequate	adequate	no response
Mississippi	surplus	slight surplus	shortage	surplus	shortage	no response
Missouri	shortage	critical shortage	critical shortage	shortage	shortage	critical shortage
Montana	no response	no response	no response	no response	no response	no response
Nebraska	adequate	shortage	shortage	adequate	shortage	adequate
Nevada	adequate	shortage	critical shortage	adequate	adequate	shortage
New Hampshire	slight surplus	critical shortage	critical shortage	shortage	critical shortage	critical shortage
New Jersey	adequate	adequate	shortage	adequate	adequate	adequate
New Mexico	slight surplus	adequate	shortage	slight surplus	adequate	shortage
New York	adequate	shortage	critical shortage	adequate	shortage	critical shortage
North Carolina	shortage	critical shortage	critical shortage	shortage	shortage	critical shortage
North Dakota	adequate	shortage	shortage	shortage	shortage	shortage
Ohio	slight surplus	shortage	critical shortage	adequate	slight surplus	adequate
Oklahoma	slight surplus	shortage	critical shortage	slight surplus	critical shortage	critical shortage
Oregon	adequate	adequate	adequate	adequate	adequate	critical shortage
Pennsylvania	slight surplus	shortage	critical shortage	slight surplus	shortage	critical shortage
Rhode Island	no response	no response	no response	no response	no response	no response
South Carolina	shortage	critical shortage	critical shortage	shortage	critical shortage	critical shortage
South Dakota	adequate	shortage	critical shortage	adequate	adequate	adequate
Tennessee	adequate	adequate	adequate	adequate	shortage	adequate
Texas	slight surplus	adequate	adequate	shortage	critical shortage	critical shortage
Utah	adequate	shortage	shortage	adequate	shortage	shortage
Vermont	shortage	shortage	critical shortage	adequate	adequate	adequate
Virginia	surplus	adequate	shortage	slight surplus	critical shortage	shortage
Washington	adequate	shortage	shortage	adequate	shortage	adequate
West Virginia	adequate	critical shortage	critical shortage	shortage	shortage	critical shortage
Wisconsin	slight surplus	shortage	critical shortage	shortage	shortage	critical shortage
Wyoming	adequate	shortage	shortage	adequate	shortage	shortage
American Samoa	critical shortage	critical shortage	critical shortage	critical shortage	critical shortage	critical shortage

SOURCE: [illegible]

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What to do when your science and math teachers abandon their classrooms

By Dan Levin

LIKE SO MANY other education problems, the shortage of qualified mathematics and science teachers struck when the school field had its eyes closed. Scattered school systems might have had difficulty finding a good physics teacher here or a sharp geometry teacher there, but no one yelled loudly enough in the mid-1970s to rouse us to the prospect that by December 1981, only half of the teachers hired to teach mathematics or science would be qualified to do so. That startling statistic was revealed in a nationwide study of mathematics and science teachers conducted by the National Science Teachers Association (N.S.T.A.).

Everyone was caught snoozing. Remarkable for the swiftness of its strike, disquieting for its dilemmas, and unsettling for its sweeping implications, the shortage of mathematics and science teachers drops yet another challenge and responsibility straight into the laps of school board members. A handful of forward-thinking school systems have been at work on the problem, but theirs is a lonely effort. Only a few state legislatures and departments of education have offered assistance. As for the federal government, no one expects much help anytime soon—in spite of the fact that the teacher shortage clearly will have an adverse effect on U.S. security and productivity.

Many of the statistics documenting the decimation of the ranks of mathematics and science teachers are alarming. Such information is so dramatic, in fact, that it's difficult to accept that no one was able to warn the education community early enough to allow significant remedial action. Consider the numbers:

- A December 1981 survey of 600 colleges and universities with teacher training programs showed a ten-year decline of 78 percent in the average number of mathematics teachers and a 64 percent decline in the average number of science teachers graduated with preparation sufficient for teaching in secondary schools.

- In 1981, 43 states reported shortages or critical shortages of mathematics teachers, 42 states reported shortages or critical shortages of physics teachers, and 38 states reported shortages or critical shortages of chemistry teachers. More than one-quarter of the mathematics teaching positions in the U.S. today are filled by teachers who are not certified or who are only temporarily certified to teach the subject, according to a study by the National Council of Supervisors of Mathematics. (Teacher certification does not always mean a teacher is qualified.)
- A 1981 survey of science teachers shows that 25 percent of younger faculty members plans to leave teaching and that five times as many mathematics and science teachers left their jobs for nonteaching positions as retired from teaching in 1980. If teachers continue to abandon the profession at their current rate, U.S. schools will lose more than one-third of all mathematics and science teachers in the next ten years. When the new surge of elementary school children reaches high school, the supply of mathematics and science teachers will have been severely depleted.

To look at statistics supplied by various states is to understand how the national problem has reached crisis proportions. Pennsylvania certified 104 physics teachers in 1972. In 1980, the figure was 12. In 1972, Pennsylvania certified 146 chemistry teachers; in 1980, 26. Mathematics certification plummeted from 1,062 in 1972 to 178 in 1980. Kentucky produced 194 science teachers and 114 mathematics teachers in 1971. Last year, only 66 science and 50 mathematics teachers were graduated. To meet the demand for mathematics and science teachers in Missouri, the state issued 43 percent more emergency teaching certificates in 1979 than in the previous year. This month, the state expects 200 mathematics teaching vacancies; only 40 of the 80 mathematics teachers the state graduated in May are expected to teach.

In the state of Washington, the number of graduates in science education in 1978 was only 70 percent of the number in 1974; in mathematics, the figure was 40 percent. At the same time, the demand for science teachers rose 35 percent, and the demand for mathematics teachers shot up 76 percent. Clearly, somebody should have been asking, What's going on here?

Today, what has been happening, and continues to happen, is obvious. Like Dustin Hoffman in "The Graduate," students completing college this year are hearing The Word whispered in their ears. Only today, The Word is not "plastics"; it's "computers." Because the computer industry can afford to pay recent graduates almost twice as much as school systems can offer first-year teachers, the best mathematical and scientific minds we produce won't even consider becoming public school teachers. As a result, a new generation of schoolchildren is bound to suffer.

An irony is afoot, of course. Our past success in science and mathematics education is largely what has led to our current dearth of teachers. The lure of the computer industry today is compelling for those who—in other times—might have been teachers. The result is a crisis of confidence in mathematics and science education that rivals the one Sputnik caused in 1957—25 years ago, in fact, next month. In short, the very computer industry built by our Sputnik-era students as they grew older is helping erode our capacity to teach mathematics and science today. The circle is closed: Once again, we look with dismay at what is perceived to be the superior preparation

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OPINIONS EXPRESSED BY THE JOURNAL OR ANY OF ITS AUTHORS DO NOT NECESSARILY REFLECT POSITIONS OF THE NATIONAL SCHOOL BOARDS ASSOCIATION

Russian schoolchildren receive in mathematics and science.

Yet, some things do change. Unlike the Eisenhower Administration and the New Frontier, the New Federalism offers no promise of a national commitment to maintain or regain U.S. superiority. In 1959, the federal government supported precollege science education by earmarking half of the annual budget of the National Science Foundation (NSF) for such programs. Today, NSF has all but abandoned science education activities. The Reagan Administration budget pared NSF science education funds from $70.7 million in 1981 to $15 million in 1982—with no money at all set aside for precollege science education.

Everyone acknowledges that the federal government cannot expiate the disparity in salaries between teachers and computer industry scientists and mathematicians. But in congressional testimony in May on the role of the National Science Foundation, NSTA President Sara Klein said other federal measures can help reduce the severity of the shortages. "The long-term shortages can be addressed by stimulating new entrants to teacher training programs in science and mathematics. This can be accomplished through NSF scholarships and NSF-supported programs of publicity on the need for teachers," she said.

Don't hold your breath. Reagan Administration support for federal education initiatives does not appear likely, although at least one of Mr. Reagan's advisers believes the federal government has a legitimate role in alleviating the shortage of qualified teachers. In a public hearing in March held by the U.S. Department of Education's National Commission on Excellence in Education, Simon Ramo, chairman of the board of the TRW-Fujitsu Co. and cochairman of President Reagan's Transition Task Force on Science and Technology, submitted his assessment of the problem: "It is doubtlessly true that some aspects of education can best be handled at local levels. But for science and mathematics education, the sensing of appropriate priorities and goals and the setting of correct funding levels can only come from a national viewpoint. Understanding the relation of education to national security, international competition, technological industry strength, and economic growth cannot be expected to exist in every decentralized area and every level of government. . . . It requires federal government leadership and support to build and preserve these resources."

The final word on the federal response to the shortage of qualified mathematics and science teachers might already have come from Education Secretary T.H. Bell, a former high school physics teacher. At a May meeting of the National Academy of Sciences, Bell suggested several remedies—all for local school boards to implement—that effectively dashed hopes that the Reagan Administration might consider the shortage an appropriate problem for federal action. (For information about how Congress plans to approach the problem, see the article beginning on page 14.) Some school systems have begun to implement some of Bell's suggestions with varying degrees of success, but others see major obstacles.

Bell urged states and school systems to consider paying mathematics and science teachers more than teachers of other subjects. This, he said, would "help stem the erosion—in fact, the bleeding off—of mathematics and science teachers into other disciplines." The controversial idea of differential pay has become a hot topic in education circles. The concept allows science or mathematics teachers to progress an extra step on the school system's salary scale, enables school systems to hire new science and mathematics teachers at a higher salary than other newly hired teachers, and offers one-time bonuses to new teachers who sign up to teach science or mathematics. This last component is called "incentive pay," and a growing number of school officials believe many states and local school boards will be forced to look hard at the prospect of enticing needed teachers with a little extra lucre.

Because the idea of differential or incentive pay is so controversial, and because teacher unions—with the possible exception of their science and mathematics teacher contingents—adamantly oppose the concept, only one major U.S. school system has instituted an incentive pay plan. The Houston schools four years ago began what they call the Second Mile Plan, which offers incentive pay to mathematics, science, and other teachers who are absent five days or fewer per year. The plan also awards bonuses to teachers who are willing to teach in inner-city schools, to bilingual and special education teachers, and to teachers whose students perform better than predicted. The bonuses range from $800 to $2,000, according to Leslie Miller, administrative assistant to the general superintendent. (For a complete description of the Second Mile Plan, see the article on page 24.)

> Incentive pay might be a fine idea, but school board leaders warn that teacher unions stand square against it

The Houston schools could afford to pay $11 million in bonus stipends in the first two years of the plan, but the incentive pay scheme has succeeded there for another essential reason: Texas has no collective bargaining law. When asked if incentive pay plans might help solve the shortage of mathematics and science teachers, every education official we spoke with from a state that has a bargaining law said such plans never could be instituted in that state's school systems.

"Incentive pay is out of the question," says Paul Gorden, executive director of the Massachusetts Association of School Committees. "No way the unions will stand for it. It flies in the face of collective bargaining."

"No bargaining unit would propose this, nor would one accept such a school board proposal," agrees Bob Daggett, legislative liaison for the New York Board of Regents. "How could a union justify higher pay for mathematics and science teachers to the rest of its members?"

Even other school systems in Texas have reservations about the Houston plan. In the Dallas suburb of Richardson, Assistant Superintendent for Personnel Jerry Miller says the Richardson school board looked at several proposals to attract and keep mathematics and science teachers. The board rejected a move to place another step on the salary scale for such teachers, and it also eschewed a one-time bonus. "We thought we might create a morale problem among those recently employed," says Miller. "We abandoned it for the time being, because some people thought it would be unfair." The Dallas schools also rejected an incentive pay plan.

Although Houston teacher union officials have denounced the plan, they admit that none of their eligible members has refused on principle to apply for the stipends. Houston teacher union officials say the same thing other union officials say when asked to suggest solutions to the shortage of mathematics and science teachers: Raise the pay scale for *all* teachers in an effort to attract the ones whose specialties are in short supply. "We're conscious of the scarcity of [certain kinds] of teachers . . ., and we're willing to do what we can to solve the problem in an equitable fashion," says Lucille Swain, coordinator of negotiations for the United Federation of Teachers in New York City. Equitable solutions do not include pay differentials, she suggested, adding that she believes most union negotiators would reject the notion of paying a new employe more than an incumbent employe.

"Today's shortage might be tomorrow's glut," notes Swain. "We've had that problem here in New York. How do you treat those people once you've brought them in at premium rates and then have to lay them off? What happens when the shortage disappears or when it switches to another area? It might be mathematics and science now, but it might be reading tomorrow. Will the school board offer incentive pay *then*?"

Incentive bonuses or differential pay scales, then, are political minefields—especially for boards engaged in collective bargaining with a teacher union. Such issues were discussed at the March hearings on science and mathematics education conducted by the National Commission on Excellence in Education and at the May meeting of the National Academy of Sciences. These gatherings were the first on a large scale to attract prominent education, academic, political, and business leaders. Numerous experts discussed general problems in science and mathematics education as well as the implications of the teacher shortage. Although several speakers mentioned incentive and differential pay as possible solutions, they proposed other alternatives as well.

Among them: increasing funds for teacher training; offering teachers aids and incentives, such as science teaching centers, laboratories, and better science curriculums; providing research opportunities for gifted students; replicating New York City's Bronx High School of Science in large school districts; encouraging closer cooperation among scientists, engineers, industrial leaders, and school officials; exempting science and mathematics teachers from mundane tasks, such as hall patrol or cafeteria duty; modifying state certification requirements to permit graduates in mathematics and science to teach at the secondary level without having to take professional education preparation courses while in college; transferring mathematics specialists into elementary schools (because student attitudes toward mathematics generally are formed in elementary school); advertising in newspapers in different cities for mathematics and science teachers; administering placement tests to high school juniors so they can make up mathematical deficiencies during their senior year; creating part-time teaching positions so qualified individuals not currently in the work force can teach; and offering 12-month contracts to mathematics and science teachers and guaranteeing them summer employment in private industry.

The most promising stopgap measures—which have been well received by teacher unions—are retraining and recertification programs that offer financial incentives. Kentucky has instituted such a program, and a handful of other states have proposals pending. Houston has a companion program to the Second Mile Plan—called Project Search—and the Philadelphia schools also have begun a retraining program. In California, where as many as 80 percent of newly employed mathematics and science teachers have been judged by their principals as unqualified to teach the subjects, the legislature has passed a bill backed by Governor Jerry Brown that would establish a statewide network of locally controlled teacher education centers, would allocate funds for training programs approved by those centers, and would initiate a program to support instructional development and exemplary projects.

In Kentucky, State Superintendent Raymond Barber ushered a bill through the legislature that established a $610,000 loan/scholarship program during the next two years for undergraduates in the state's 23 colleges that offer teacher education programs. Students are eligible for three-year loans of $2,500 per year in return for a promise to teach mathematics or science in Kentucky schools. For each year they teach, one year of their loan becomes a scholarship. If the teacher quits, moves to another state, or takes a job in industry, the teacher must repay the loan at the current Treasury Bill rate plus 3 percent, according to Frank Howard, science consultant in the state education department. Seventy-five undergraduates are taking advantage of the loan program this fall. Next summer, says Howard, certified teachers with degrees in fields other than mathematics or science are eligible for $833-per-year retraining loans.

On the other hand, New York State failed to pass a series of bills (offered by the Board of Regents) that were aimed at alleviating the mathematics and science teacher shortage in the state; officials said the bills would be reintroduced. The proposals include establishing 100 fellowships for part-time graduate study by prospective teachers of mathematics and science. Thirty fellowships would be reserved for the retraining of teachers of subjects other than mathematics or science whose positions were abolished because of declining enrollments. As a condition of the fellowship, each recipient would have to agree to teach mathematics or science in an elementary or secondary school in the state. Another bill would establish Regents consultantships in mathematics in each of the state's 11 judicial districts. These consultants would strengthen school system inservice training programs and would help develop new curriculums.

North Carolina is another state that has begun to attack the problem with legislative proposals, although lawmakers failed to pass a $200,000 scholarship program to recertify teachers. A revised version of the bill should reach the legislature in January, according to Robert Jones, director of the mathematics division in the North Carolina State Department of Public Instruction. The bill would provide competitive grants of $5,000 for recertification training or for mathematics or science teachers who want to upgrade their skills. Already in place, says Jones, is a loan program for prospective mathematics and science teachers who promise to teach in the state's schools.

Kentucky, California, New York, North Carolina, and perhaps a few other states sense that the federal government most likely will remain aloof in the crisis over mathematics and science education. Lawmakers and education officials in those states recognize the urgency of the shortage and at least have begun to explore ways to solve the problem. These officials understand that individual school systems—especially small or rural ones—are in no position to retrain teachers or to offer financial incentives. Only large systems, such as Houston and Philadelphia, and perhaps some medium-sized districts can set aside the funds to retrain teachers or to offer to pay for tuition, books, and other miscellaneous costs involved in retraining.

Coupled with their Second Mile Plan, the Houston schools' Project Search constitutes the boldest local foray aimed at stemming the exodus of teachers into industry. The schools sought out elementary school teachers with some college credit in science or mathematics, knowing that teachers in Texas need only 14 hours of college credit to be able to teach the subjects. This past summer, the schools offered the teachers four three-credit courses during two six-week sessions and not only paid for tuition and books but paid the teachers stipends of $250 per course as well. The schools designed the courses and used their own teachers to teach them. Graduate credits were awarded through Houston Community College, which is part of the Houston public school system.

In return for the stipend, says Mira Baptiste, director of staff development, teachers signed contracts agreeing to teach in the system for three years—or else repay the district. "We found that money motivates," Baptiste says of the overwhelming response to the program. The schools hoped to attract enough candidates to be able to retrain 50 mathematics and 50 science teachers; 300 teachers showed up at an introductory meeting. The schools then screened the prospects for good academic records, good teacher evaluations, and good recommendations from principals. Baptiste explains the Houston schools' do-it-yourself approach: "We can no longer look to the universities to define our needs or to fulfill them. We were looking to regain our control. . . . The universities can't even get people to come or make them stay in education. We know people are getting siphoned off even before they finish school."

"We have to do something to make teaching attractive," Baptiste emphasizes. To reinforce graduates' intention to teach, Houston schools also raised the starting pay for a first-year teacher to $16,000—a 14.2 percent increase.

On a less ambitious scale, the Philadelphia schools are involved in a retraining program to fill 45 vacancies in high school mathematics classes. Elementary teachers or English or social studies teachers may take recertification courses at a reduced price at one of seven area colleges or universities, according to Alexander Tobin, the Philadelphia schools' director of mathematics education. The school system initiated contact with all candidates, says Tobin.

Nearly 280 were interested; 110 met the qualifications (three years' teaching experience was one requirement); and 75 actually started retraining last May.

With the shocking statistics on how few new mathematics and science teachers are emerging from teacher education institutions, and with the new-found ability of longtime teachers to snub the profession in favor of higher paying, less nerve-wracking jobs with computer companies, state and local education officials have begun to search for answers to a problem that probably will get worse before it gets better. Incentive or differential pay proposals no doubt will strain teacher/board member relations. So without federal help, which is not expected, retraining programs sponsored at the state or local level appear to offer the best hope for a short-term solution. ☐

This bold incentive pay plan pits capitalism against teacher shortages

By Leslie Miller
and Elaine Say

THE DAYS are long gone when the public could assume teachers would work for low wages because of the inherent "joys of teaching." Business and industry continue to lure many of our most talented teachers away from the classroom with the promise of higher pay and less aggravation. In the Houston public schools (K-12, enr. 93,000), a shortage of mathematics, science, bilingual, and special education teachers has led us to reject the unlikely proposition that financial rewards are unnecessary to attract qualified people to the teaching profession.

We decided to act, to move beyond the traditional lock-step salary schedules in an effort to attack the teacher shortage. Consequently, we established the Second Mile Plan, an incentive pay plan for teachers.

The purpose of the plan is to recognize and reward classroom teachers who, on their own initiative, go beyond the minimum requirements to meet the instructional needs of their students—teachers who go "the second mile." The plan provides financial incentives—over and above the teachers' normal salary—for teachers to accept the additional challenges of teaching in curriculum areas or campus locations where critical shortages exist.

Unquestionably, the absence of a mandatory collective bargaining law in Texas has enabled the Houston schools to proceed with the Second Mile Plan.

To earn a bonus, teachers must meet specific minimum requirements and then apply for each stipend. To be eligible, an employe must (1) hold a valid and appropriate teaching certificate or permit, (2) be assigned to a school or instructional site, (3) be paid on the teacher salary scale, (4) have an acceptable performance evaluation, (5) have limited absences (five absences have been permitted since the 1980-81 school year); and (6) be a full-time teacher, nurse, or librarian.

An employe may qualify for a bonus stipend in six categories:

- *High-priority location.* Teachers willing to teach in schools with high concentrations of educationally disadvantaged students are eligible for $2,000 stipends.
- *Critical staff shortage.* High school mathematics and science teachers are eligible for $800 stipends. Stipends for special education teachers range from $600 to $900. Bilingual education teachers may earn an extra $1,000.
- *Outstanding teacher attendance.* Teachers who are absent five or fewer days during the year may trade in their unused leave days at a rate of $100 per day.
- *Professional growth.* Teachers who complete college courses in curriculum areas related to their teaching assignment or who voluntarily attend inservice classes operated by the school system are eligible for stipends. For each six-hour block of college coursework (or 72-hour block of

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Here's how Houston's Second Mile Plan applies to one teacher

This chart shows how an eligible teacher receives extra compensation in various components of the Second Mile Plan.

Components	**Stipend paid**
Outstanding educational progress	$800
High-priority location	$750
Critical shortage	$800
Professional growth	$400
Attendance	$500
Unique campus assignments	$0
Total:	$3,250

Henry Foster is a science teacher at a secondary school in a high-priority location. This is his fourth year there. He has perfect attendance. He completed six hours of approved graduate credit in science during the school year. Teachers in his school will earn outstanding educational progress stipends based on test data. Foster currently is on Pay Grade 8, Step 10, of the salary schedule. Taken together, these stipends increase his salary by 15.2 percent. (Base salary $21,370, plus $3,250 stipends, equals $24,620 total salary.)

approved inservice training), the stipend is $300.

- *Outstanding educational progress.* Test score averages for each school site are predicted on the basis of previous academic achievement and a number of other factors. If the school's average score exceeds the predicted score, each eligible teacher receives an $800 stipend.
- *Unique campus assignment.* Teachers who teach at a campus for which no test data are available—either because the students have not been at the school long enough to be tested or because the students are not able to be tested using standardized tests—are eligible for stipends ranging from $450 to $750.

Reactions to the Second Mile Plan, predictably, have been varied. The three teacher organizations that represent Houston teachers oppose the plan. Spokesmen for the groups argue that money spent on the plan should be put into across-the-board raises or fringe benefits for *all* teachers. But a survey conducted by the Houston schools' research and evaluation department shows that more than half of the systems' teachers thought the Second Mile Plan should be continued. (One-third of the teachers said it should be abandoned, and the remainder said they had no opinion or did not respond to the question.) Naturally, those who received stipends rated the program more favorably than those who did not.

In the first year of the plan (1979-80), two-thirds of the system's teachers applied for and received one or more stipends. In the second year, the figure dropped to one-third of the teachers, largely because the attendance requirement was tightened from a maximum of ten permitted absences to the more stringent five absences.

Since the plan's inception, the school board enthusiastically has supported the Second Mile Plan, especially the component that addresses Outstanding Educational Progress (OEP). As a symbol of a faculty's accomplishment in being designated an OEP school, an OEP flag is flown over the campus. In some communities, the PTA also has honored faculty members with receptions or ceremonies for their accomplishments.

To administer the plan, the district hired two clerks in the payroll office. Other staff members assumed additional functions, such as evaluating the program, responding to teachers' questions, providing yearly recommendations for changes, and hearing appeals.

In the three years since the plan's initiation, it has undergone numerous changes. Categories for stipends have been added and deleted. The amounts of various stipends have been increased. Baseline requirements have been modified. Each of these changes was prompted by input from teachers, administrators, and the school board.

After three years, the positive results are numerous:

- At all elementary grade levels, the average academic achievement of students in grades one through six met or exceeded the expected grade placement. Achievement test scores increased by from one to two months in grades seven through eleven from 1979-80 to 1980-81.
- The number of teacher vacancies at the beginning of the school year decreased from 613 in August 1979 to 376 in August 1981.
- In the face of increased staffing requirements for bilingual and mathematics teachers, vacancies in critical staff shortage areas decreased from 251 in August 1979 to 186 in August 1980.
- The median turnover rate in high-priority schools decreased from 18.2 percent to 15.1 percent between 1980 and 1981.
- Approximately $11 million has been paid to approximately 10,000 teachers in the first two years of the Second Mile Plan. The average stipend was $936, which had the net effect of increasing these teachers' 1979-80 salaries by 6.4 percent.
- Teacher absences decreased from an average of 9 days in the 1978-79 school year to an average of 7.6 days in the 1980-81 school year.

The Houston schools' Second Mile Plan is a proven example of incentive pay. Any other school system considering adopting some form of incentive pay should realize that its plan must be tailored to the specific needs of its system. We see our plan as an evolving one.

With newspaper headlines continuing to warn of increasing teacher shortages, we view the Second Mile Plan as one way to reduce the impact in our district. More important, teachers are provided financial rewards for helping our schools meet the challenges they face. ☐

THE NEW YORK TIMES, TUESDAY, AUGUST 10, 1982

EDUCATION

U.S. Tackling Crisis In Science and Math

By GENE I. MAEROFF

CONGRESS and the state legislatures are joining the search for ways to ease the shortage of science and mathematics teachers, and corporations are being coaxed into helping as well, as it becomes increasingly obvious that the nation's public schools cannot solve the problem alone.

At the heart of the various proposals is a desire to attract into teaching young people who would otherwise be lured to higher-paying jobs in business and industry. One way of doing this, as proposed in several pending bills, is to subsidize the education of students who will become teachers of mathematics and science.

In addition, there is growing interest in persuading business and industry to become involved. A bill in Congress proposes to do this by awarding tax credits to corporations that give summer jobs to such teachers as a method of elevating their income and expertise.

Inherent in the various proposals is the controversial idea that it is desirable to give teachers of science and mathematics higher incomes and further advantages than teachers of other subjects receive, an approach that the teachers' unions oppose.

The problem facing the high schools has much in common with the trouble in colleges of engineering, where many graduating seniors who might otherwise pursue doctorates and join the faculty are instead leaving for high salaries in the business world, creating a scarcity of engineering professors.

However, the corporations themselves, notably Exxon and Union Carbide, have begun to assist the colleges by awarding grants to encourage doctoral studies in engineering to provide faculty members for the future. Some corporations are also examining ways they might share some employees with universities, thus preventing them from leaving teaching altogether.

The public schools hope they can emulate some of this cooperation. The schools have become alarmed by statistics showing that during the last decade the production of secondary teachers has declined by 78 percent in mathematics and 64 percent in science. The schools are losing five times as many science and mathematics teachers every year to industry as to retirement.

Despite the objections of the American Federation of Teachers and the National Education Association, a few public school systems, for example those in Houston and Oklahoma City, are already trying to attract mathematics and science teachers by giving them higher salaries than other teachers. And two months ago, the Virginia State Board of Education recommended the same approach for school dis-

Continued on Page 24

U.S. Tackling Science and Math Teacher Crisis

Continued From Page 21

tricts throughout the state.

The president of the National Council of Teachers of Mathematics, Stephen S. Willoughby, thinks that paying some teachers more than others could stir morale problems, but he says it is necessary in light of the crisis. "Differential pay isn't healthy because it leaves people with the notion that some teachers are worth more than others, but I support it as a stop-gap measure," said Dr. Willoughby, who is also director of mathematics education at New York University. "The solution I recommend, however, is to double the pay of every teacher in the country."

The most direct attack on the problem in Congress — supported by a wide array of educational organizations, including the National Association of Secondary School Principals — was proposed last month in bills introduced by Senator John Glenn of Ohio and Representative Dave McCurdy of Oklahoma, both Democrats.

Under the Glenn-McCurdy proposals, students preparing to be science and mathematics teachers would get loans each year as undergraduates. The loans would be forgiven if recipients taught in an elementary or secondary school for at least four years.

A companion bill would give tax credits to businesses for providing summer positions to mathematics and science teachers, and for sending employees who have teaching credentials into the schools as part-time teachers.

The summer jobs could be a kind of bonus that circumvents the issue of differential pay. Without summer income, the National Education Association estimates, the average annual salary for a teacher is $18,97[illegible], hardly enough to deter those with mathematical training from entering, for instance, the more lucrative computer industry.

"There is difficulty in finding summer employment that would provide sufficient additional income to allow our science and math teachers to stay within the school system," Mr. Glenn said on the floor of the Senate.

While the bills await consideration, at least two states are moving independently to entice students into careers as public school mathematics and science teachers by awarding them forgivable loans. For the first time this fall, college students in Kentucky will be able to get loans of $2,500 a year that they will not have to repay if they become science and mathematics teachers in elementary and secondary schools. The Legislature has appropriated $[illegible],000 for the first two years of the program. In Alabama, a new program will award loans covering the full cost of tuition, room, board and books to students who will not have to repay the money if they become high school teachers of mathematics, chemistry, physics, biology or general science.

Some authorities say that any long-range solution will also have to include the participation of business and industry. The corporations have been the magnets pulling away young science and mathematics graduates, but they also have the resources to help the high schools change the situation. A steady supply of future employees trained in mathematics and science is, after all, in the best interest of the companies themselves.

Making Jobs More Competitive

Lewis M. Branscomb, vice president and chief scientist at I.B.M., said in an interview, "We need to make the job of being a high school teacher of science or mathematics more competitive." He is interested in the Glenn-McCurdy bills, but wonders about the efficacy of some of their provisions.

"Most companies have summer employment programs, but they are primarily for college students," he said of the proposal for summer employment of mathematics and science teachers. "What we don't want to have happen is for teachers to get summer jobs, and discover that the work is less stressful and more attractive, and leave teaching."

While business and industry have vastly more experience in working with higher education than with high schools, some collaborative programs are already operating. Xerox regularly sends technical people from its Retrographics Business Group in Rochester and Tampa, Fla., into public elementary schools in those cities to conduct science lessons, including experiments that tie in with the scheduled curriculum.

Whatever happens cannot happen soon enough to suit school officials. The number of mathematics and science courses being taught by people with inadequate backgrounds in the subjects is growing, according to the National Science Teachers Association, and 50.2 percent of teachers newly assigned to mathematics and science classes last year lacked the appropriate credentials.

New Jersey Star-Ledger, September 13, 1982

State aims to fill math, science gap

By ROBERT J. BRAUN

New Jersey's two educational departments will soon launch a crash program designed to meet the state's worsening shortage of science and mathematics teachers—a program that could put retired executives into public school classrooms and retrain unemployed teachers.

In their first major effort at interdepartmental cooperation, Higher Education Chancellor T. Edward Hollander and Education Commissioner Saul Cooperman are scheduled to announce creation of an 18-member task force to consider solutions to the shortage.

The committee has been given a short deadline for answers—Feb. 1, 1983—and one top higher education official says he believes the first efforts to find new math and science instructors could be in place by the spring.

"We don't have a lot of time," said Edward Goldberg, the state's assistant higher education chancellor.

The joint efforts—which mark a healing of the long-standing rift between the two departments—come just as the number of new teachers in the field is approaching zero. New Jersey's state colleges, the major source of new public school instructors for the state, graduated only 30 new math teachers and 27 new science teachers this year.

Those figures, however, might actually be an exaggeration because some of those instructors might be certified in other fields as well—fields they could pursue instead of math or science.

Meanwhile, math and science teachers are leaving New Jersey's public schools at a faster rate. A survey conducted by a science teachers association indicated that, in just 185 schools in the last two years, private industry had lured away 132 public school math and science teachers.

Projected on a statewide basis, the loss is rapidly outstripping the ability of teacher training institutions to provide new instructors. A national study, which included New Jersey in its sample, claimed that the supply of the teachers

(Please turn to Page 6)

State drive aims at math, science teacher gap

(Continued from Page One)

one 20 per cent behind demand.

The state Department of Education already has declared an emergency shortage of math and science teachers in 17 of New Jersey's 21 counties. The emergency designation permits districts to use uncertified teachers—some without bachelor's degrees—to teach the subjects.

Goldberg, who is coordinating Higher Education's efforts, said he believes the state will implement short-term solutions while beginning a long-range recruitment drive aimed at junior high and elementary school youngsters to create interest in math and science teaching.

"I don't want to prejudge what the committee will do, but it's clear we will have to look somewhere for a pool of available persons from which new math teachers could be drawn immediately," he said.

The most obvious places to look, he said, are the ranks of New Jersey firms that rely heavily on employees with strong math and science backgrounds.

The state, he said, will look to "retired, just retiring and about to retire" executives to replace at least some of the missing math and science teachers.

"We think we can interest some of those who worked as mathematicians, statisticians and scientists to opt for a second career instead of retirement," Goldberg said.

Goldberg said the state would contact industrial personnel departments, many of which have preretirement counseling, to promote the possibility.

For those expressing an interest, the state would provide what Goldberg called a "field-based training program."

He pointed out that, under the new teacher education standards adopted by both the state Board of Higher Education and Board of Education, subject matter is stressed with methodology linked to practice teaching.

"These people would obviously have all the subject matter background they could need," he said. "We want to get them directly into the classroom to observe and to learn."

Efforts to bring practitioners into the classroom have been frustrated in the past by certification requirements. However, the declaration of the emergency in the state would permit noncertified teachers—such as the retirees—to work in public school classrooms.

Another potential source of new math and science teachers, Goldberg said, are teachers in other fields who, because of declining enrollments, have lost their jobs. Unlike the retirees, they have the field experience—but not necessarily the subject matter knowledge.

"Our aim would be to identify teachers with an aptitude for math or science and provide them with intensive, useful and modern training in the fields," he said.

The retraining efforts, he said, would be based in two to four higher education institutions in the state. The courses would not be part of the colleges' regular program, according to Goldberg, so they could be started up anytime and last only as long as necessary.

New Jersey already has two possible models. St. Peter's College has a master's degree program aimed at teachers from other disciplines. William Paterson College recently enrolled 30 students in a math-science curriculum aimed specifically at elementary school teachers who have lost jobs because of declining enrollments.

Goldberg said he believed "pilots" of the retraining program would be in operation by the spring—with the full effort in place "certainly no later than September."

While the short-term plans are pursued, higher education and education department officials will be attempting to determine how to reach the children who could become the future math and science teachers.

The departments will try to interest children at the junior high—and perhaps even elementary level—in the possibilities of math or science teaching careers.

Special emphasis will be placed on recruiting women and minorities, now underrepresented in the field, Goldberg said. Rebecca Lubetkin, who directs Rutgers University's Institute for Sex Equity, is on the task force. The organization conducts training programs for students and teachers aimed at increasing the number of young women entering the sciences.

The state also is likely to investigate the possible use of a program at the State University of New York at Stony Brook that is aimed at making the fields more attractive to minorities.

"At some point in his or her life, a child makes the initial decision to want to become a teacher," Goldberg said. "For a variety of reasons, these decisions are often accompanied by a decision to be a teacher of something else besides math or science.

"We want to get to children before they rule out the possibility of teaching in those fields."

In the past, the two departments have differed on one possible solution to the teacher shortage: The differential in pay offered to persons with science and math backgrounds by private industry. Higher Education has doubted the usefulness of offering "bonuses" to teachers to pursue math—while the education department has cited the differential as the single most important problem in the shortage.

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The idea, however, was promoted by former Education Commissioner Fred G. Burke. Higher Education officials are hopeful Cooperman, Burke's successor, will be more flexible.

Goldberg said the pay differentials would be studied by the task force. But he pointed out that collective bargaining agreements would prevent paying more to teachers based on the subject areas they teach—and that a surplus of teachers in other areas makes paying bonuses to all teachers unnecessary.

More important, even if the contract problem could be overcome, small financial incentives would not likely influence teachers, he said.

"If a good math teacher is offered a $7,000 raise to quit the schools and join a computer company, he or she is not likely to stay because some school board is paying $1,000 or $2,000 bonuses," he said.

Goldberg insists that an adequate number of young persons are opting for teaching careers. The problem is not the choice of careers, but the choice of subjects to be taught.

"I'm convinced the answer won't be in providing financial incentives. I don't think they'll work and I don't think they're necessary," he said.

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So far, Cooperman has said little about the problem—with most of the energies of his early tenure taken up with reorganizing the education department.

However, he said he has directed his staff to cooperate "fully" with the joint venture and has repeatedly announced his intention to work more closely with the higher education department than had his predecessor.

Not solving the problem, warn both state and national education officials, could have serious consequences. The National School Boards Association has called the shortage a threat to "national security" because education will fail to provide the technically trained persons needed to advance science and technology.

One national survey pointed out that the shortage of teachers in the field is at least partially contributing to waning interest among children. According to the survey, only one-sixth of the nation's high school juniors and seniors are taking advanced math courses. A third of all sophomores who are taking math are enrolled only in remedial courses.

The National Council of Mathematics Teachers warned that the current drive by school boards to purchase microcomputers makes little sense because of the likelihood so few young persons will be able to understand the basic math necessary to acquire skill on the machines.

"At best, we are going to have a widening gap between those who understand technology and those who don't—the creation of two cultures based on technical literacy, one controlling the other," Goldberg said.

"At worst, we face serious deficits in our ability to continue with technological advancements," he said.

Syndicated column, August 17, 1982

A Conservative View

James J. Kilpatrick

Wanted: Math, science teachers and students

WASHINGTON – Harrison Schmitt and Margaret Heckler performed a useful public service the other day when they called a joint press conference to publicize a bill they are sponsoring in the field of science and technology. They are tackling a national problem with profound implications for our industrial future.

Schmitt is a Republican senator from New Mexico, Mrs. Heckler a Republican representative from Massachusetts. Their concern may be simply stated: We are running short on scientists, engineers and mathematicians. As a nation, we cannot afford to fall behind.

The two sponsors cite all kinds of evidence to support their apprehension. Over the past 16 years, the percentage of U.S. patents granted to foreign inventors has increased from 22 percent in 1965 to 40 percent in 1981. Even before the current recession began, the rate of increase of productivity in the United States was the lowest of industrialized nations. Foreign competitors have outpaced our manufacturers of TV sets, tape recorders and other high technology items.

Poor preparation in high schools

MUCH OF THE POTENTIAL problem lies in the public schools. About half of all high school graduates, Schmitt says, have taken no mathematics or science beyond the 10th grade. This poor preparation at the secondary level disqualifies them for higher mathematics in college. Our graduate schools award about 150,000 advanced degrees in the sciences every year, but the need is for 50,000 more.

Because of this shortfall, there are not nearly enough qualified teachers of mathematics to go around. The National Science Teachers Association reports that the number of pre-college science teachers dropped by 65 percent in the past decade, while the number of pre-college math teachers dropped by 77 percent. The figures are – pick your adjective – dismaying, disturbing, shocking.

Our colleges and universities at one time employed about 17,000 faculty members in engineering. Approximately 1,700 of those positions remain vacant for want of qualified applicants. Private industry has scooped up many engineering graduates who might make excellent teachers, with the result that the institutions of higher learning are hurting. Research that should be done is not being done.

To define a serious problem is not necessarily to provide the right answer. The Schmitt-Heckler bill proposes one more matching categorical grant program with all the trappings of guidelines, plans, applications, awards and reports that have become so familiar in recent years.

Incentives for unusual promise

THE SPONSORS envision incentives that would range from $25,000 to $100,000 a year for untenured faculty members who demonstrate unusual promise in their fields. A separate program would undertake to improve the skills of pre-college teachers of science and mathematics. Schmitt and Mrs. Heckler propose total outlays of tax funds, to be administered by the National Science Foundation, ranging from $15 million next year to $105 million in 1987.

In the context of budgets that will range in this period from $750 billion to a trillion dollars, the sums are insignificant. The outlays probably could be justified constitutionally in the name of national defense if for no other reason. Even so, the grants and awards proposed under this legislation are the very kind of incentives that could be handled by the states and by the private sector. As Schmitt acknowledges, some highly encouraging efforts already are being made by these sources.

In any event, the need for stepped-up programs in science and mathematics is apparent. This is not our only educational shortcoming – the disastrous decline in the teaching of foreign languages is another – but in the brave new computerized world that lies ahead, the shortage of teachers and graduates in higher mathematics presents a crucial problem. It is too late in this session of the 97th Congress for the Schmitt-Heckler bill to get anywhere, but the two members have given the country a sobering matter to think about.

Kansas City Times, June 2, 1982

Editorials/Comments

Math and Science Are Dying

In comparison with other countries, young America could be called scientifically and mathematically illiterate. Not only have Scholastic Aptitude Test scores declined — the mean dropped from 502 in 1963 to 466 in 1980 — but the disciplines traditionally get a stingy share of classroom time.

Proficiency tests as graduation requirements validate the sorry facts. Last week 81 Kansas City, Kan., seniors still had not passed that district's proficiency test in fundamental math, one covering basic skills teachers expect seventh graders to know. They had 11 chances to try. A daily specialized instruction period in mathematics and science for eighth graders in the Kansas City School District has been added to the curriculum as part of the five-year strategic plan. Already, achievement scores, particularly in math, have shown noticeable improvement. But tests won't solve the problem and neither will the enlightened efforts of individual districts; nothing short of a national crusade similar to the undertaking after the Russian Sputnik launch in 1957 will.

Blame administrators content to baby sit and school boards unwilling or unable to demand more; blame patrons who don't hold them accountable. It's all part of the scientific ho-hums affecting the U.S. where elementary students do well to get an hour of science and four hours of math a week. In the Soviet Union, East Germany, China and Japan, by the sixth grade, children have specialized study in mathematics, biology, chemistry, physics and geography; they'll spend triple the time on those subjects given by even the most science-oriented student here. In addition their school day and week are longer and vacation far shorter.

While this country is already paying a price in a shortage of classroom teachers — half the high school math and science instructors this year were unqualified, hired with emergency certificates — other countries recognize the importance of these disciplines in meeting future economic and social challenges. National policies promote them, thus encouraging students and eliciting citizen support.

At a recent conference at the National Academy of Sciences, the secretary of education lamented while the secretary of defense worried about the future shortage of scientists and engineers. President Reagan sent a message expressing concern that the problem could endanger America's industrial strength in the future. With such a consensus, what are we waiting for? Another dramatic Soviet breakthrough with which we can try to catch up? Again?

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION

Part 1

THURSDAY, SEPTEMBER 30, 1982

House of Representatives, Subcommittee on Elementary, Secondary, and Vocational Education and Subcommittee on Postsecondary Education, Committee on Education and Labor,

Washington, D.C.

The subcommittee met, pursuant to notice, at 9:15 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the subcommittee) presiding.

Members present: Representatives Perkins, Andrews, Goodling, and Erdahl.

Saff present: John F. Jennings, counsel; and Nancy Kober, legislative specialist.

Mr. **Erdahl** [acting chairman]. The subcommittee will come to order.

I want to assure the panelists and others here and for the record that this is not a palace coup, but Chairman Perkins has asked me to get the meeting underway.

Very likely before the morning is out we will hear the bells ring because there are several key votes on the floor today.

My name is Arlen Erdahl, a member of this subcommittee. I would like to submit for the record Mr. Perkins' statement, but I identify myself with it.

The Subcommittee on Elementary, Secondary, and Vocational Education is concluding hearings today on the status of mathematics and science education.

During the past 2 days, we have heard some alarming statistics about the crisis confronting our schools in mathematics and science education.

This crisis is evidenced by shortages of teachers in mathematics and science, a drop in the number of students taking mathematics and science, and declines in student achievement in advanced mathematics and science.

This situation is especially critical in light of the demands of new technology and our declining stature in the international marketplace.

We have a number of bills pending before the committee to upgrade mathematics and science education, to increase the supply of teachers, and to provide teacher training.

One of the bills I introduced is H.R. 7135, the National Education and Economic Development Act. This bill authorizes funds to school districts to assist them in mounting programs in mathematics, science, technology, and foreign languages.

I would like to commend the National School Boards Association for working with me on this legislation.

Today, we are very happy to have a distinguished panel involved in administration of education with us today. I will mention all the names of the panelists and then we will go in the record as I have mentioned them.

We have Dr. Joan Parent, the first vice president of the National School Boards Association, from Foley, Minnesota; Mrs. Iris Carl, area five instructional specialist, Houston Independent School District; Bardyl Tirana, vice president, Technics, Inc., representing the California Commission on Industrial Innovation; and Bonnie Van Dorn, director, Association of Science and Technology Centers, Washington, D.C.

Dr. Parent, we are especially happy to welcome you as a fellow Minnesotan. Foley is not such a big town, but it is an important town in central Minnesota not far from another town called St. Cloud that is a little bigger.

You may proceed.

STATEMENT OF M. JOAN PARENT, FIRST VICE PRESIDENT, NATIONAL SCHOOL BOARDS ASSOCIATION, FOLEY, MINN.

Dr. PARENT. Thank you, Mr. Chairman.

My name is Dr. Joan Parent and I am first vice president of the National School Boards Association [NSBA], and a member of the National Science Foundation's Commission on Pre-College Education in Mathematics, Science, and Technology.

Incidentally, my degree is in veterinary medicine and not in education.

NSBA is the only major education organization representing local school board members. Throughout the Nation, approximately 90,000 of these individuals, through their State organizations, are association members. They are responsible for the education of more than 95 percent of the Nation's public school children.

Currently marking its 42d year of service, NSBA is a federation of State school boards associations with direct local school board affiliates, constituted to strengthen local lay control of education and to work for the improvement of education.

Most school board members are elected public officials. Accordingly, they are politically accountable to their constituents for both education policy and fiscal management.

As lay, unsalaried individuals, school board members are in the rather unique position of being able to judge legislative programs purely from the standpoint of public education, without consideration to their personal professional interests.

As first vice president of NSBA and a member of the Pre-College Commission of NSF, I want to extend our thanks for having the opportunity to testify before this committee.

At the outset, I would like to commend Chairman Perkins for his leadership in sponsoring H.R. 7135—the National Education and Economic Development Act, the NEED bill of 1982.

In my testimony, I plan to address the following three points:

One, the need, as a national priority, to address science, math, foreign languages, and technology;

Two, the specific local school district concerns in implementing a national program; and,

Three, the features of H.R. 7135 that we believe are essential to achieving significant progress in each of the aforementioned areas.

I turn first to the statement of national need.

We do not believe it is an exaggeration to say that the United States stands on the threshold of a technological revolution that will change the way Americans live, work, and think.

Indeed, the computer, peripherals, and telecommunications are changing 20th century society, as the steam engine and electricity altered the 19th century.

This, of course, comes as no surprise to members of this committee. You know of the rapid changes in electronics, communications, robotics, and biotechnology and their transformation of the workplace from "blue collar" and "white collar" jobs to "white coat employment."

The transformation of the U.S. labor force in the Nation's brief history tracks the progressive mechanization of work that attended the evolution of the agrarian republic into an industrial world power.

In 1820, more than 70 percent of the labor force worked on the farm. By 1900, fewer than 40 percent were engaged in agriculture.

Today, employment in the services in the United States is approaching the same 70 percent that were bound to the soil a century and a half ago. Only 32 percent of the labor force is still engaged in the production of goods and a mere 3 percent is employed in agriculture.

Arthur D. Little, Inc. projects that by 1990, between 40 and 50 percent of all American workers will be making daily use of electronic-technical equipment. Some 38 million terminal-based work stations of various kinds are by then likely to be installed in offices, factories, and schools.

Second, it seems fair to assume that, at least in the near future, the Nation and businesses within our borders will be continually facing increased competition from abroad.

Every member of this committee is all too familiar with the effects of the competition generated by Japan and Germany. Even though the United States has the lead in the development of new and sophisticated technological advances, our competition has focused its efforts on improving production quality standards and on breakthroughs in process engineering.

They have been extremely successful and are pulling away from us. These forces are even more significant when we see that the U.S. rate of productivity has declined each year since 1965, and that the actual level of productivity has decreased since 1979.

Additional competition comes from the Third World nations. These massive reductions in labor costs enable industries to produce both parts and products more cheaply.

Consequently, the prospect that a sizeable portion of the labor-intensive assembly work in the high-technology field will be attracted away from the United States looms on the horizon.

We believe that there will be major shifts required in the labor force during the transition into technology-based society which will bring about almost continuous retraining of future workers.

According to Peter Drucker, 10 to 15 million jobs will disappear in the next 25 years. The elimination of 15 million jobs is particularly significant when one considers that today's workers will account for 90 percent of the work force in 1990.

The range of data and respected authorities pointing to the changes which America will have to undergo over this decade to advance the economy, to strenghen its position in world markets, and to maintain national defense is inexhaustible.

The one compelling conclusion is that technology is the key to attaining our national goals in each of these areas, and education is the key to technology.

While education is primarily a State and local responsibility, 50 States and 16,000 school districts cannot realistically be expected to organize themselves to address issues of a national or international scale.

Nor should the Federal Government leave to chance that other levels of government will recognize and adequately fulfill national priorities.

If it is in the national interest for our citizenry to be prepared to assume productive roles in the new technological era, then it should be in the national interest for the Federal Government to assume a partnership role with State and local government to educate schoolchildren to succeed in the coming era.

In short, we believe that our ability as a nation to compete in the future will be seriously restricted unless Federal, State, and local leaders begin to address the growing national shortage of skilled engineers, scientists, technicians, mathematicians, and those able to teach them.

The solution to the problem must begin at the elementary level and continue through the professional ranks.

I turn now to the concerns of local school boards.

In defining the Federal role, notice should be taken of the magnitude of the educational problem which we are facing.

Let us draw your attention to a couple of examples.

One, despite recent increases in math and computer courses, one-half of all high school graduates in the United States take no mathematics or science beyond 10th grade.

Two, only 8 percent of all high school students are taking the rigorous course curriculum, including advanced math and sciences.

Three, nationally, enrollment in remedial math programs at 4-year institutions of higher education increased 72 percent between 1975 and 1980, compared to an overall increase in enrollment of 7 percent.

In developing solutions for upgrading the opportunity for each child to seek and participate in quality programs in mathematics, science, technology, and foreign languages, NSBA does have a number of concerns.

While our testimony addresses the positive mechanisms of H.R. 7135, our basic concerns are as follows:

One, nationwide, local school districts do not have adequate funds to invest in such need items as:

First, salary levels necessary to attract and retain qualified teachers;

Second, the acquisition of hardware and software, as well as other costs necessary to upgrade, expand, and modernize curriculum offerings;

Third, the in-service training of teachers and other personnel to meet the challenges of new curriculum, as well as in the use of technology for the classroom; and,

Fourth, access to information programs, and resources, outside of the school system which can assist school districts in building and evaluating effective programs.

Two, in developing a national program, it must be recognized that the priorities and resources surrounding each local community are such that each school districts must have the flexibility to plan and implement programs comprehensively, without the risks of grantsmanship or the constrictions of "single-answer" solutions.

Three, while an effective solution to America's long-term productivity needs requires a strong elementary and secondary foundation—including the development of technical skills—the mission of K-12 education should not be distorted to being viewed as solely one of occupational training—as distinguished from educating the future citizenry, which would include preparation for work.

The first two of these concerns require some elaboration. First, with respect to funding, we have witnessed financial turbulence over the past couple of years which has left almost half of the States with broad-based increased in their tax structures and continued financial instability.

The persistent recession, Federal program changes and budget cuts, along with self-imposed tax and spending limitations, continue to threaten the financial security of many States and local school systems.

Local school districts want to make major improvements; however, the Federal Government needs to assist with part of those retooling costs.

Some have suggesting that the Federal Government has little or no role to play in strengthening the local school districts' performance in the national infrastructure.

However, it is important to remember that it was the Federal Government's major role that lead American industries in agriculture, aeronautics, nuclear power, communications, genetic engineering, and emerging technologies.

Only the Federal Government is in a position to exert necessary leadership to insure action of an appropriate scale and with the adequate lead times.

The machines that are invented, improved and put into operation throughout the economy depend on a steady accretion in the pool of knowledge and on the availability of enough technicians.

If the Nation has to wait for large corporations and hundreds and thousands of State and local units of government to respond to the training needs of future workers from the ground up, it could be too long a wait.

The U.S. economy, for better or worse, is a pluralistic system in which government, nonprofit institutions, and privately owned companies have complementary relations.

No one of them, left to its own devices, can prosper in a technologically sophisticated world.

The second area of concern for local school districts is the breadth of scope and flexibility necessary in the creation and implementation of improved programing in mathematics, science, foreign languages, and technology.

With the approximately 16,000 local school districts nationwide, a comprehensive approach is required.

If the program is not large enough, the local districts will not think in terms of overall, systemwide strategies, but rather in narrow single-purposed terms.

Also, districts need flexibility—flexibility to hire or retain a math or science teacher in one district or purchase hardware and software in another district or develop a program with local businesses in still another.

Some districts may have a shortage of math and science teachers while, at the same time, have a surplus of teachers in other subject areas.

In that case, we would hope that the Federal assistance would be utilized to retrain those teachers through a variety of means.

For example, one option would be to fund a semester or two fellowship in which the teachers would maintain their salaries and steps-in-grade but be released to attend school on a full-time basis.

This type of release time is well understood by industry and the Federal agencies. Retraining is a major financial investment and local school districts are not capable of the effort alone.

The area of technology hardware and software purchasing is also very capital-invensive. Many districts around the Nation have already invested heavily in computers—micro and mini—and courseware development.

However, much of the investment to date has been spotty. What is needed at the local level is some encouragement from the Federal Government to take some risks in allocating local and State resources in hardware and software procurement.

We see at least three different approaches to the use of technology in local school districts:

One, technologies as tools of science; two, technologies as objects of study; and, three, technologies as deliverers of instruction.

If we are to integrate the use of technology in all of our Nation's classrooms—not just in pilot projects and prototypes—we need to develop a Federal role to stimulate the large-scale development of high quality educational courseware, software, and materials and to facilitate the acquisition of appropriate hardware.

If we are expected to be successful, we need trained faculty who are prepared to use technology wisely. If we are to capitalize on the strengths but avoid the dangers of the information technologies, we need continued research and development activities to determine long-term benefits and dangers.

I turn now to the solution and the NEED Act of 1982.

Again, Mr. Chairman, we commend you for the introduction of H.R. 7135 and applaud the comprehensive, well-designed character of the bill.

We believe the bill recognizes that the key to productive capacity is technology and human resources and, finally, that education is the integral component.

By focusing upon math, science, foreign languages and technology, you have targeted on four fundamental components that support our ability to compete more effectively.

We believe that the NEED bill provides five major principles which will assure its operation success. They are:

One, a focal formula maintenance program of sufficient local size and scope to encourage the vast majority of local school districts to plan and implement a comprehensive program;

Two, a program design based on an analysis of each district's need; the flexibility in this component will also encourage participation of nontraditional local organizations;

Three, a local accountability and program evaluation—the bill achieves new approaches to local accountability by placing the emphasis on the local electorate rather than bureaucratic control, and by emphasizing "peer review," for example, as a means for developing, evaluating, and disseminating quality programs;

Four, a State role to utilize their capacities to give technical assistance, develop exemplary projects, coordinate among State level agencies and organizations; these activities are essential to local district program services; and finally, the State should be the agent in the funds distribution system with the Department of Education; and,

Five, a Department of Education nationwide role—the Secretary needs to be responsible for directing research and development activities through institutions and private contractors. This function is beyond the reach of both State and local educational agencies. The Secretary is also in the best position to obtain cooperation from other Federal departments, national and international business interests and national organizations as we look for advice on future designs of these types of programs, as well as to make grants which address innovations and needs reflecting a national perspective.

A full abstract of H.R. 7135 is attached to my prepared statement and I would ask that it be placed in the record at this point.

Mr. Erdahl. Without objection, so ordered.

[Abstract of H.R. 7135 follows:]

NSBA

THE NATIONAL EDUCATION AND ECONOMIC DEVELOPMENT ACT OF 1982

The "NEED" Bill (H.R. 7135)

Sections I, II: Title, Findings and Purposes

The National Education and Economic Development Act of 1982 strengthens the capability of school districts to develop high quality educational programs that undergird the nation's defense and economic well-being. The focus of the Act is mathematics, science, foreign languages and technology programs. The Act provides a collaborative effort by all levels of government, business and industry, higher education, and researchers to assist school districts in addressing the technological literacy skills fundamental to individual educational and career opportunities in a technological era. The Act aids school districts in fashioning a comprehensive approach to all aspects of the issue including existing teacher shortages in significant areas, limited access to high quality technological hardware and software, inadequate availability of computer software that meets sound educational objectives and curricular offerings in technological literacy that are appropriate for elementary and secondary students with varying educational aspirations and needs, including students who enter the job market upon high school graduation, as well as for those who continue their schooling in 2, 4, 6 and 8-year degree programs.

Title I Funding

The program authorizes $1 billion for FY 1983 and $2 billion for 1984 which computes to approximately $25 per school child in FY 1984 and $50 per school child in FY 1985. The additional three years of the five-year authorization provides such sums as may be necessary. The funds are allocated accordingly: 10% to the Secretary of Education for programs of national significance, 1% to the trust territories and Indian reservations, and 5% to the State education agencies with the remainder distributed to school districts according to the population of children aged 5-17 years.

Title II - Local School District Programs

The State educational agency will distribute its allocation to local school districts on the basis of local student count minus 5% for use in State administration and programs. The school district will receive funds when the school district has submitted a three-year comprehensive plan that the local school board (1) has approved, (2) has certified that due consideration was given to State educational agency recommendations, and (3) has a comprehensive plan for a program that is authorized by this Act costing, at minimum, $25,000 in local, State and Federal dollars.

In addition to a variety of assurances, the school district plan will include a statement of the district's educational goals (including student achievement level goals), a description of the district educational program utilizing the funds of the "NEED" Act and the district's use of community resources including a peer review evaluation by other school districts that promotes the quality standards of the local program.

The authorized activities permit school districts to comprehensively respond to a number of areas of critical need, including (1) the shortage of teachers in math, science and technology; (2) the acquisition of technological equipment and software; (3) the updating of teaching staff, administration and school board members, as needed, in the course content areas, (4) student evaluation, selection and evaluation of technological hardware and software, (5) the special requirements of the gifted, handicapped, limited Englishspeaking and severely economically disadvantaged child in mathematics, science, foreign languages and technology; and (6) collaborative efforts with community resources including local businesses, universities, and public agencies such as libraries and museums. The participation of children enrolled in private schools is also provided consistent with procedures in the ECIA Chapter I program.

Title III - State Programs and Administration

To receive funds, a State educational agency will file with the Secretary of Education, a three-year State plan which includes (1) a description of State programs and activities conducted to enhance school district work in mathematics, science, foreign languages and technolgoy; (2) a consultation process with the State Advisory Council; (3) a maintenance of education expenditure effort of not less than 90% of all State and local funds in the second preceding year; and (4) a prohibition of using "NEED" Act funds to determine levels of State aid to local school districts.

The State education agency shall determine whether local school district plans are consistent with the requirements of federal law. When necessary, the State education agency may comment upon local school district plans. The review shall occur within 60 days after the plan is submitted by the school district. A State agency may require written certification by the local school board that its comments were fully considered. Upon receipt of the certification, the local school district will receive funding within 15 days. The State education agency shall monitor local school district activities. Any requirement imposed upon a local school district as a result of State policy shall be identified as a State, not a Federal, requirement.

Of the 5% reserved for the State, 20% or $75,000, whichever is higher, may be used for administration, up to 20% may be used for a State Advisory Council, and at least 60% shall be used for State programs. The State programs may include a large variety of activities including the following: research in the curriculum improvement; upgrading of certification standards for math, science and foreign language teachers; experimental and pilot programs; technical assistance to local school districts; programs to promote student interest in the target subject areas and to encourage local school district collaboration with appropriate higher education and private sector interests; and information dissemination of important State and local mathematics, science, foreign languages and technology program efforts.

To receive funds, a State Advisory Council shall be appointed either by the governor or, if elected, by the State board of education. The council shall consist of a diverse and representative group of individuals who are knowledgeable about employment needs and curricular and technological innovations. The advisory council shall advise the State in the development of the State three--year plan and the State's administration of the Act, review and make recommendations on the pertinent educational, demographic and employment trends affecting school districts and transmit to the Secretary of Education and the National Advisory Council its findings and recommendations. The advisory council shall provide at least one public meeting a year at which the public might express its views.

Title IV - Programs of National Significance

From 10% of the Act's resources, the Secretary of Education shall make grants to and contracts with institutions of higher education, research laboratories and centers, State and local education agencies and other education agencies. The programs of national significance shall be used to address problems of wide Federal interest pertaining to the development of high quality education programs including: evaluation of and experimentation with hardware technologies and corresponding software for their elementary and secondary classroom use; assessment of national progress in elementary and secondary programs in science, mathematics, foreign languages and technology; trends in teacher education, availability, and compensation; and establishment of exemplary and pilot programs and other innovative activities that will improve elementary and secondary student knowledge.

Beginning in FY 1985, the Secretary of Education shall make a report to Congress. The report will address the State of (1) educational technology, (2) the overall quality of elementary and secondary programs in mathematics, science, foreign languages and technology; (3) the administration and operation of the Act; and (4) describe the programs of national significance.

Indian children on reservations shall be provided services from the Act's funds through a transfer to the Secretary of the Interior.

A National Advisory Council on Education and Technology consisting of a representative group of 27 knowledgeable individuals from federal agencies and other sectors shall be appointed by the President. The purpose of the advisory council is to provide information to the President, Congress and the public. The National Advisory Council shall (1) review the effectiveness of the Act; (2) identify emerging trends and needs in educational technology; (3) note the status of teacher preparation, incentives and qualifications in the target program areas; and (4) conduct a wide variety of studies to improve the knowledge base for use of policymakers and education practitioners in areas such as teacher preservice and inservice programs, curriculum, rates of student participation in the targeted programs and the use of outside community resources to improve schooling. Further, the council will address and research pertinent issues pertaining to the connection between education and the nation's defense.

Title V - General Provisions

The Secretary of Education may withhold payments to a State education agency if after adequate notification, the State education agency does not comply with the Act. The State education agency can file a petition in a U.S. court of appeals if it is dissatisfied with the agency and disagrees with the judgment of the Secretary.

Dr. PARENT. In conclusion, Mr. Chairman and members of this subcommittee, members of our association are deeply concerned about the future of our country and education's role in contributing to a better future.

Approximately 1 year ago, Secretary Bell appointed a blue ribbon panel—National Commission on Excellence in Education—to encourage the highest order of literacy and academic competence possible in the public schools.

The Commission is scheduled to issue its report in early 1983. At that time, the Commission will make recommendations on how to improve teaching, learning, and management in the schools.

Although we are as eager as anyone to know their recommendations, we believe that the time for action is now.

We commend the chairman for proposing H.R. 7135 and encourage the members of the committee to support this legislation.

We believe that the NEED bill is the best approach for improving the quality of educational services at the elementary and secondary level.

Further, we believe the time to act must be counted in months, not years.

Finally, to delay or to diminish the Federal role now will only lead to more costly future remediation for the Nation.

Thank you.

Mr. ERDAHL. Thank you. Thank you very much, Dr. Parent, for that statement.

I am sure it comes not only from you, but as you as a representative of the National School Boards Association.

There will be some questions later, but let us go through the panel first.

[Prepared statement of Dr. M. Joan Parent follows:]

PREPARED STATEMENT ON BEHALF OF THE NATIONAL SCHOOL BOARDS ASSOCIATION, PRESENTED BY DR. M. JOAN PARENT, FIRST VICE PRESIDENT, NSBA

- Introduction

My name is Dr. Joan Parent and I am First Vice President of the National School Boards Association (NSBA) and a member of the National Science Foundation's Commission on Pre-College Education in Mathematics, Science and Technology. NSBA is the only major education organization representing local school board members. Throughout the nation, approximately 90,000 of these individuals, through their state organizations, are association members. They are responsible for the education of more than ninety-five percent of the nation's public school children.

Currently marking its forty-second year of service, NSBA is a federation of state school boards associations with direct local school board affiliates, constituted to strengthen local lay control of education and to work for the improvement of education. Most school board members are elected public officials. Accordingly, they are politically accountable to their constitutents for both education policy and fiscal management. As lay, unsalaried individuals, school board members are in the rather unique position of being able to judge legislative programs purely from the standpoint of public education, without consideration to their personal professional interests.

As First Vice President of NSBA and a member of the Pre-College Commission of NSF, I want to extend our thanks for having the opportunity to testify before this committee. At the outset, I would like to commend Chairman Perkins for his leadership in sponsoring H.R. 7135 -- The National Education and Economic Development Act (the NEED bill of 1982). In my testimony, I plan to address the following three points: (1) the need, as a national priority, to address science, math, foreign languages and technology, (2) the specific local school district concerns in implementing a national program, and (3) the features of H.R. 7135 that we believe are essential to achieving significant progress in each of the aforementioned areas.

- Statement of National Need

We don't believe it is an exaggeration to say that the United States stands on the threshhold of a technological revolution that will change the way Americans live, work, and think. Indeed, the computer, peripherals, and telecommuncations are changing 20th Century society, as the steam engine and electricity altered the 19th Century. This, of course, comes as no surprise to members of this committee. You know of the rapid changes in electronics, communications, robotics, and bio-technology and their transformation of the workplace from "blue collar" and "white collar" jobs to "white coat employment."

The transformation of the United States labor force in the nation's brief history tracks the progressive mechanization of work that attended the evolution of the agrarian republic into an industrial world power. In 1820, more than 70 percent of the labor force worked on the farm. By 1900, fewer than 40 percent were engaged in agriculture. Today, employment in the services in the United States is approaching the same 70 percent that were bound to the soil a century and a half ago. Only 32 percent of the labor force is still engaged in the production of goods and a mere three percent is employed in agriculture. Arthur D. Little, Inc. projects that by 1990, between 40 and 50 percent of all American workers will be making daily use of electronic-technical equipment. Some 38 million terminal-based work stations of various kinds are by then likely to be installed in offices, factories and schools.

Second, it seems fair to assume that, at least in the near future, the nation and businesses within our borders will be continually facing increased competition from abroad.

Every member of this committee is all too familiar with the effects of the competition generated by Japan and Germany. Even though the United States has the lead in the development of new and sophisticated technological advances, our competition has focused its efforts on improving production quality standards and on breakthroughs in process engineering. They have been extremely successful and are pulling away from us. These forces are even more significant when we see that the U.S. rate of productivity has declined each year since 1965, and that the actual level of productivity has decreased since 1979.

Additional competition comes from the third world nations. These massive reductions in labor costs enable industries to produce both parts and products more cheaply. Consequently, the prospect that a sizeable portion of the labor-intensive assembly work in the high-technology field will be attracted away from the United States looms on the horizon. We believe that there will be major shifts required in the labor force during the transition into a technology-based society which will bring about almost continuous retraining of future workers. According to Peter Drucker, 10 to 15 million jobs will disappear in the next 25 years. The elimination of 15 million jobs is particularly significant when one considers that today's workers will account for 90% of the workforce in 1990.

The range of data and respected authorities pointing to the changes which America will have to undergo over this decade to advance the economy, to strengthen its position in world markets, and to maintain national defense is inexhaustible. The one compelling conclusion is that technology is the key to attaining our national goals in each of these areas, and education is the key to technology.

While education is primarily a state and local responsibility 50 states and 16,000 school districts cannot realistically be expected to organize themselves to address issues of a national or international scale. Nor should the federal government leave to chance that other levels of government will recognize and adequately fulfill national priorities. If it is in the national interest for our citizenry to be prepared to assume productive roles in the new technological era, then it should be in the national interest for the federal government to assume a partnership role with state and local government to educate school children to succeed in the coming era.

In short, we believe that our ability as a nation to compete in the future will be seriously restricted unless federal, state and local leaders begin to address the growing national shortage of skilled engineers, scientists, technicians, mathematicians, and those able to teach them. The solution to the problem must begin at the elementary level and continue through the professional ranks.

- Concerns of Local School Boards

In defining the federal role, notice should be taken of the magnitude of the educational problem which we are facing: Let us draw your attention to a couple of examples:

- Despite recent increases in math and computer courses, one half of all high school graduates in the United States take no mathematics or science beyond tenth grade.

- Only 8% of all high school students are taking the rigorous course curriculum, including advanced math and sciences.

- Nationally, enrollment in remedial math programs at four-year institutions of higher education increased 72% between 1975 and 1980, compared to an overall increase in enrollment of 7%.

In developing solutions for upgrading the opportunity for each child to seek and participate in quality programs in mathematics, science, technology, and foreign languages, NSBA does have a number of concerns. While our testimony addresses the positive mechanisms of H.R. 7135, our basic concerns are as follows:

- Nationwide, local school districts do not have adequate funds to invest in such need items as:
  1. salary levels necessary to attract and retain qualified teachers;
  2. the acquisition of hardware and software, as well as other costs necessary to upgrade, expand, and modernize curriculum offerings;
  3. the inservice training of teachers and other personnel to meet the challenges of new curriculum, as well as in the use of technology for the classroom;
  4. access to information programs, and resources, outside of the school system which can assist school districts in building and evaluating effective programs.

- In developing a national program, it must be recognized that the priorities and resources surrounding each local community are such that each school districts must have the flexibility to plan and implement programs comprehensively, without the risks of grantsmanship or the constrictions of "single-answer" solutions.

- While an effective solution to America's long-term productivity needs requires a strong elementary and secondary foundation (including the development of technical skills), the mission of K-12 education should not be distorted to being viewed as solely one of occupational training -- as distinguished from educating the future citizenry, which would include preparation for work.

The first two of these concerns require some elaboration. First, with respect to funding, we have witnessed financial turbulence over the past couple of years which has left almost half of the states with broad-based increases in their tax structures and continued financial instability. The persistent recession, federal program changes and budget cuts, along with self-imposed tax and spending limitations, continue to threaten the financial security of many states and local school systems. Local school districts want to make major improvements; however, the federal government needs to assist with part of those retooling costs. Some have suggested that the federal government has little or no role to play in strengthening the local school districts' performance in the national infrastructure. However, it is important to remember that it was the federal government's major role that lead American industries in agriculture, aeronautics, nuclear power, communications, genetic engineering and emerging technologies.

Only the federal government is in a position to exert necessary leadership to ensure action of an appropriate scale and with the adequate lead times. The machines that are invented, improved and put into operation throughout the economy depend on a steady accretion in the pool of knowledge and on the availability of enough technicians. If the nation has to wait for large corporations and hundreds and thousands of state and local units of government to respond to the training needs of future workers from the ground up, it could be too long a wait. The U.S. economy, for better or worse, is a pluralistic system in which government, nonprofit institutions and privately owned companies have complementary relations. No one of them, left to its own devices, can prosper in a technologically sophisticated world.

The second area of concern for local school districts is the breadth of scope and flexibility necessary in the creation and implementation of improved programming in mathematics, science, foreign languages and technology. With the approximately 16,000 local school districts nationwide, a comprehensive approach is required. If the program is not large enough, the local districts will not think in terms of overall, system-wide strategies, but rather, in narrow single-purposed terms. Also, districts need flexibility -- flexibility to hire or retain a math or science teacher in one district or purchase hardware and software in another district or develop a program with local businesses in still another.

Some districts may have a shortage of math and science teachers while, at the same time, have a surplus of teachers in other subject areas. In that case, we would hope that the federal assistance would be utilized to retrain those teachers -- through a variety of means. For example, one option would be to fund a semester or two fellowship in which the teachers would maintain their salaries and steps-in-grade but be released to attend school on a full-time basis. This type of release time is well understood by industry and the federal agencies. Retraining is a major financial investment and local school districts are not capable of the effort alone. The area of technology hardware and software purchasing is also very capital intensive. Many districts around the nation have already invested heavily in computers (micro- and mini-) and courseware development. However, much of the investment to date has been spotty. What is needed at the local level is some encouragement from the federal government to take some risks in allocating local and state resources in hardware and software procurement. We see at least three different approaches to the use of technology in local school districts:

1. technologies as tools of science,
2. technologies as objects of study, and
3. technologies as deliverers of instruction.

If we are to integrate the use of technology in all of our nation's classrooms (not just in pilot projects and prototypes), we need to develop a federal role to stimulate the large-scale development of high quality educational courseware, software and materials and to facilitate the acquisition of appropriate hardware. If we are expected to be successful, we need trained faculty who are prepared to use technology wisely. If we are to capitalize on the strengths but avoid the dangers of the information technologies, we need continued research and development activities to determine long-term benefits and dangers.

- The Solution -- NEED Act of 1982

Again, Mr. Chairman, we commend you for the introduction of H.R. 7135 and applaud the comprehensive, well-designed character of the bill. We believe the bill recognizes that the key to productive capacity is technology and human resources and finally, that education is the integral component. By focusing upon math, science, foreign languages and technology, you have targeted on four fundamental components that support our ability to compete more effectively.

We believe that the NEED bill provides five major principles which will assure its operational success. They are:

- a local formula maintenance program of sufficient local size and scope to encourage the vast majority of local school districts to plan and implement a comprehensive program;

- a program design based on an analysis of each district's need; the flexibility in this component will also encourage participation of non-traditional local organizations;

- a local accountability and program evaluation -- the bill achieves new approaches to local accountability by placing the emphasis on the local electorate rather than bureaucratic control, and by emphasizing "peer review," for example, as a means for developing, evaluating, and disseminating quality programs;

- a State role to utilize their capacities to give technical assistance, develop exemplary projects, coordinate among state level agencies and organizations; these activities are essential to local district program services; finally, the state should be the agent in the funds distribution system with the Department of Education;

- a Department of Education nationwide role -- the Secretary needs to be responsible for directing research and development activities through institutions and private contractors; this function is beyond the reach of both state and local educational agencies; the Secretary is also in the best position to obtain cooperation from other federal departments, national and international business interests and national organizations as we look for advice on future designs of these types of programs, as well as to make grants which address innovations and needs reflecting a national perspective.*

- Conclusion

Mr. Chairman and members of this committee, members of our association are deeply concerned about the future of our country and education's role in contributing to a better future. Approximately one year ago, Secretary Bell appointed a blue-ribbon panel (National Commission on Excellence in Education) to encourage the highest order of literacy and academic competence possible in the public schools. The Commission is scheduled to issue its report in early 1983. At that time, the Commission will make recommendations on how to improve teaching, learning and management in the schools. Although we are as eager as anyone to know their recommendations, we believe that the time for action is now!

We commend the Chairman for proposing H.R. 7135 and encourage the members of the committee to support this legislation. We believe that the NEED bill is the best approach for improving the quality of educational services at the elementary and secondary level. Further, we believe the time to act must be counted in months, not years. Finally, to delay or to diminish the federal role now will only lead to more costly future remediation for the nation!

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* A full abstract of H.R. 7135 is attached.

Mr. **Erdahl.** Next I would like to call Mrs. Iris Carl, area 5 instructional supervisor, Houston Independent School District.

Mrs. Carl, you may proceed.

STATEMENT OF IRIS M. CARL, AREA 5 INSTRUCTIONAL SUPERVISOR, HOUSTON INDEPENDENT SCHOOL DISTRICT

Mrs. **Carl.** Good morning, Mr. Chairman.

I wish to thank the members of the House of Representatives Education Subcommittee for the invitation to appear today and bring testimony on the critical shortage of teachers of mathematics and science.

I am Iris Carl, a member of the Board of Directors of the National Council of Teachers of Mathematics.

I am an instructional supervisor in the Houston Independent School District in Houston, Tex. My experiences as an educator have been in public education as a teacher and an administrator.

My assignments have ranged from kindergarten through senior high school with major emphasis in the area of mathematics.

The urban school district that I represent is the largest in the State of Texas and presently the fifth largest in the United States.

The Houston Independent School District has 235 schools, 10,000 teachers, and 190,000 students. Ethnically, the current enrollment is 26 percent white, 44.3 percent black, and 29.7 percent Hispanic.

The impending teacher crisis was recognized early in Houston. For many years, the district had opened school with hundreds of classrooms unmanned by certified teachers.

In the high schools, for example, thousands of students were being graduated without ever having had a qualified teacher of mathematics. A system was needed to address the many factors that contributed to this shortage.

Determined to counteract this exigency, the district devised a plan utilizing the basic supply and demand principle of free enterprise.

Differentiated pay scales were produced to attract and hold qualified teachers in the critical areas of mathematics, science, and bilingual and special education.

I will discuss what the plan is.

The second mile plan, an incentive pay plan for teachers, was implemented in the Houston Independent School District in the 1979–80 school year.

The plan was developed at the direction of the board of education to address the following needs:

One, reward teachers whose students exhibit high levels of academic growth;

Two, stabilize faculties in schools where turnover has been high;

Three, attract teachers in areas where critical shortages exist;

Four, improve teacher attendance; and

Five, provide extended instructional programs.

I turn now to who may participate.

An HISD teacher who meets the baseline requirements listed below may participate in the plan. To be eligible for participation, the teacher must:

One, hold a valid teaching certificate or permit appropriate to the teaching assignment;

Two, be assigned to a school or instructional site;

Three, be paid on pay grades 7, 8, or teacher with doctorate;

Four, have a score of 3.0 or better on the most recent post-assessment for beginning teachers;

Five, have five or fewer days of absence during the current school year;

Six, have no unexcused absences; and

Seven, be a full-time teacher, nurse, learning resources specialist—librarian—or ESAA secondary facilitator.

I turn now to what the six categories are that qualify for incentive pay.

The first is the high priority location of teaching assignment. This refers to schools with a concentration of educationally disadvantaged students. Stipends for the 1981-82 school year were $2,000.

The second is the critical staff shortage. This refers to teaching assignments in secondary science, secondary mathematics, bilingual education, and special education.

The stipends for mathematics and science are $800, special education is $600 to $900; and bilingual, $1,000.

All of these amounts, I might interject here, are to be upgraded to $2,000 for this school year.

The third is the outstanding teacher attendance. This refers to attendance that exceeds baseline requirements. The stipends range from $500 to $50, based on 0 to 5 days of absence.

Fourth is professional growth. This refers to successful—grade of B or better—completion of college courses in curriculum and instruction appropriate to the current teaching assignment or district in-service.

Also, teachers who return to college to acquire certification in areas where critical teacher shortage exist are eligible for a stipend.

Courses in educational administration, counseling, guidance, and general education do not qualify.

For each 6-hour block of university coursework or 72 hours of approved district in-service, the stipend is $300.

If the courses are in an area where critical teacher shortages exist, the stipend is $400 over and above the $300.

Additionally, any courses where tuition is paid through an HIDS program will not count toward the stipend.

The fifth is the outstanding education progress. Teachers assigned to schools where the school average for student's rate of academic gain as measured by standardized tests is greater than the mathematically predicted school achievement goal may be eligible for a stipend.

We use the Iowa test of basic skills.

Thus, each school will be competing against itself. If the school average qualifies, each eligible teacher assigned to the school will receive the stipend.

For an individual teacher on a qualifying campus to be eligible for this stipend, he or she must meet the baseline requirements stated earlier.

Teachers at schools which exceed their predicted target will be eligible for the OEP stipend—projected amount of $800.

Teachers at the top 10 percent of the elementary schools, junior and middle schools, and senior and special schools which exceed their target score by the greatest amount will receive an additional $400.

Sixth is the unique campus assignment. Teachers who teach at a campus for which no test data are available, either because the students are not at the school long enough to be tested or because the students are not able to be tested using standardized tests, may receive the unique campus assignment stipend.

These teachers are not eligible for outstanding educational progress stipend. These school sites are subject to annual review.

The unique campus assignment is a special assignment in that it relates to the schools that are established for the youngsters who are potential dropouts or have other problems and are sent there on a rotating basis.

Some of the categories that are on the list now may not be on the list in the future. The 1981–82 stipend provided ranges from $450 to $750.

I turn now to when the stipends are paid.

Three components—critical staff shortage, high priority location, and unique campus assignment—are paid in June.

Teacher attendance, outstanding educational progress, and professional growth stipends are paid in the fall of the school year following the school year for which they are earned.

Fall stipend payments are contingent upon a teacher's return to the district. The only exception is for teachers who retire.

A teacher who resigns during the year will not be eligible for a stipend payment.

If a teacher loses eligibility during the school year through promotion, resignation, or failure to meet baseline requirements, the stipend will not be prorated.

Application forms for this voluntary plan are sent to the schools and returned to the stipend office for processing. Teachers must apply for the stipends for which they qualify.

I turn now to what the impact has been.

The research evaluation and accreditation department of the district conducted an impact study of the second mile plan.

The results have been reassuring. Teacher vacancies in the critical areas decreased from 251 in August 1979 to 21 in August 1982.

Within the same time, teacher attendance increased from 95.6 percent to 96.1 percent. An advantage of improved teacher attendance is the diminished need for substitute teachers.

In the first year, 1979–80, the decrease in teacher absences netted the district a saving of $12,499. In high priority location schools, vacancies are minimal and staff stability has increased.

Most significant are the achievement levels of students. Elementary students are at or above grade level while middle and secondary students show continuous improvement.

I would like to put in the record the achievement test scores.

Mr. **Erdahl.** Without objection, so ordered.

[Achievement test scores follow:]

ACHIEVEMENT TEST SCORES FOR GRADES 1–6, 1979–82

Grade	Expected grade placement	Composite score (ITBS)		
		1979–80	1980–81	1981–82
1	[1] 1.8	2.0	1.9	1.9
2	[1] 2.8	3.0	2.9	3.0
3	3.7	3.9	3.8	4.0
4	4.7	4.9	4.9	4.8
5	5.7	5.8	5.9	5.9
6	6.7	6.7	6.7	6.7

[1] Expected grade placement for grades 1 and 2 was 1.8 and 2.8 for 1978–79. In 1980–81, testing was completed 1 month earlier, therefore the expected grade placement was 1.7 and 2.7.

Note.—No cause and effect relationship between OEP dimension and achievement growth is implied. The Houston ISD had implemented several programs over the past several years designed to improve achievement.

ACHIEVEMENT TEST SCORES FOR GRADES 7–12,[1] 1979–82

Grade	Expected grade placement	Composite score		
		1979–80	1980–81	1981–82
7	7.7	7.2	7.4	7.3
8	8.7	8.1	8.3	8.4
9	9.7	8.5	8.6	8.7
10	10.7	9.7	9.9	10.0
11	11.7	10.6	10.8	11.0
12	12.7	(2)	11.9	11.8

[1] Testing at grades 7–9 took the ITBS and grades 10–12 took the Tests of Achievement and Proficiency (TAP).

[2] No testing at grade 12 with the TAP in 1979–80.

Mrs. CARL. The cost of implementation in 1979 was approximately $11 million. Stipends ranging from $300 to $3,500 were paid to two-thirds of the teachers in the district in that first year.

In the secondary year the number of recipients decreased due to the change in baseline attendance requirements from 10 to 5 absences and the removal of the extended instruction time stipend.

An expenditure of $11 million is anticipated for 1982–83 with an expected increase in the number of participants.

I would like to place in the record the 1982–83 second mile plan components.

Mr. ERDAHL. Without objection, so ordered.

[Components table referred to follows:]

1982-83 SECOND MILE PLAN COMPONENTS

Component	B-1 Program #	Estimated Payments (Budget)	Funding Source	Date of Scheduled Payment
Teachers (Function 11):				
High Priority Location:				
Elementary Teachers (FOAA-13 schools)	01	$ 730,000	General Fund	June 17, 1983
Elementary Teachers (50 schools)	N/A	2,600,000	Title I	June 17, 1983
Secondary Teachers	00	1,335,000	General Fund	June 17, 1983
Critical Staff Shortage	02	* 1,500,000	General Fund	June 17, 1983
Outstanding Teacher Attendance	04	1,500,000	General Fund	October 20, 1983
Professional Growth	03	325,000	General Fund	November 2, 1983
Outstanding Educational Progress	05	2,600,000	General Fund	December 16, 1983
Project Recruit	06	10,000	General Fund	December 16, 1983
Unique Campus	07	50,000	General Fund	June 17, 1983

TOTAL 82-83 Second Mile - General Fund $8,050,000
Title I $2,600,000

* Represents budgeted amount only. Actual payments are expected to be approximately $2.6 million, if the Board of Education approves a maximum stipend of $2,000.

Proposed changes in the Second Mile Plan include increasing the teacher shortage stipends to $2,000. A proficiency test is also being considered as an added baseline requirement.

Mrs. **Carl**. I turn now to what the attitudes of the school and the community are.

The Houston School Board unanimously endorses and supports the second mile plan. Teachers are divided. When surveyed, 55 percent of the recipients and 36 percent of the nonrecipients agreed that this plan offers a desirable reward for extra effort.

However, 58 percent of the recipients and 39 percent of the nonrecipients agree that the plan should be continued.

Generally, neither recipients or nonrecipients indicated that the plan was an incentive for them to work harder, continue teaching, come to work every day, or develop themselves professionally.

The highest level of discontent was in the area of salaries. More than 50 percent of the teachers in each survey expressed some dissatisfaction with their pay relative to the amount of work that is done.

Teacher organizations are on record as opposing the second mile plan. Texas does not have collective-bargaining laws.

The Houston community actively favors the plan. Campus activities honoring teachers who have received the outstanding educational progress stipends have become a regular form of recognition.

I turn to what is next.

Coupled with the second mile plan is Project Search. Districts can no longer rely on colleges and universities to provide us with sufficient numbers of teachers in mathematics, sciences, and other critical areas.

Project Search was developed in 1981-82 as a self-help project.

This summer elementary teachers with some college credit in mathematics or science were encouraged to apply for this new program. Twenty-five teachers were selected for retraining in each discipline, based on their academic ratings and teacher assessments, for secondary certification.

During two 6-week sessions, four courses were offered through a local college and graduate credit given. Tuition, books, and a $250 stipend per course were provided by the district.

Teachers were required to sign contracts agreeing to teach for the Houston Independent School District for 3 years or repay the district.

The first 50 teachers are presently in their new middle school assignments on emergency certification.

To make the profession of teaching more attractive, the district has raised the starting pay for 1982-83 for first-year teachers to $16,000—a 14.2-percent increase.

A compressed salary schedule—from 15 to 10 steps has been structured to make the commitment real.

I would ask that the 5-year projection step reduction chart be placed in the record at this point.

Mr. **Erdahl**. Without objection, so ordered.

[Chart referred to follows:]

FIVE-YEAR PROJECTION

Step Reduction

Pay Grade 7

	81/82	82/83	83/84	84/85	85/86	86/87	
B	1400	1600	1600	1600	1600	1600	
1	1441	1610	1610	1610	1610	1610	
2	1483	1620	1620	1620	1620	1620	
3	1529	1630	1630	1630	1630	1630	
4	1578	1667	1667	1667	1667	1667	
5	1628	1720	1720	1720	1720	1720	
6	1682	1775	1775	1775	1775	1775	
7	1739	1833	1833	1833	1833	1833	
8	1800	1896	1896	1896	1896	1896	
9	1864	1962	1962	1962	1962	1962	
10	1931	2032	2032	2032	2032	2032	
10a	1981	2105	2105	2105	2105	2105	B
11	2056	2159	2159	2159	2159	2159	1
11a	2093	2241	2241	2241	2241	2241	2
12	2135	2281	2281	2281	2281	2281	3
12a	2173	2327	2327	2327	2327	2327	4
13	2222	2369	2369	2369	2369	2369	5
13a		2422	2422	2422	2422	2422	6
14			2543	2543	2543	2543	7
14a				2670	2670	2670	8
15					2804	2804	9
15a						2944	10

8

Mrs. **Carl**. The second mile plan is not solely responsible for the positive changes that have taken place. The Houston Independent School District interfaces with business and industry.

Students and teachers intern in the field. They return enthusiastic, committed, and current. Industry personnel, provided release time, teach in the district schools.

College training in special graduate programs is district funded. Houston is involved in State and national task forces that articulate the problem.

Each contributes to the success experienced. However, the incentive pay plan is seen as a viable method of rewarding teachers who fulfill the special needs that face the district.

Flexibility and receptively to teacher suggestions are key elements in the success of the second mile plan.

The Houston Independent School District is forwarding to this committee the most recent study on the second mile plan.

We stand ready to offer whatever assistance we can to this committee. It has been an honor for me to have this opportunity to present this testimony today.

Thank you for your kind attention.

Mr. **Erdahl**. Thank you.

Since you began your testimony, we have been joined by our distinguished chairman, Mr. Carl Perkins.

You just indicated you have another commitment and may have to leave soon.

Chairman **Perkins**. Let me compliment the entire panel.

I have too many appointments. I like to attend all the hearings. Congressman Erdahl is doing a great job. I have been very much interested in your testimony.

But at this time I do not have questions. We will continue.

Mr. **Erdahl**. Our next member of the panel is Mr. Bardyl Tirana, vice president, Technics, Inc., representing the California Commission on Industrial Innovation.

Mr. Tirana, you may proceed.

STATEMENT OF BARDYL TIRANA, VICE CHAIRMAN, TECHNICS, INC., REPRESENTING THE CALIFORNIA COMMISSION ON INDUSTRIAL INNOVATION

Mr. **Tirana**. Thank you, Mr. Chairman.

I think I will not summarize my statement. It speaks for itself. I would not try to amend the work of the California Commission on Industrial Innovation.

It is an excellent report covering the concerns of this committee in its entirety.

I would, therefore, ask that this be placed in the record.

Mr. **Erdahl**. Without objection, so ordered.

[Prepared statement of Bardyl Tirana and California Commission follow:]

PREPARED STATEMENT OF BARDYL TIRANA, VICE CHAIRMAN, TECHNICS, INC., REPRESENTING THE CALIFORNIA COMMISSION ON INDUSTRIAL INNOVATION, SAN JOSE, CALIF.

My name is Bardyl Tirana and I am presently vice chairman of Technics, Incorporated, a manufacturer of capital equipment for the electronics industry headquartered in San Jose, California. I have also served as a member-at-large of the District of Columbia Board of Education. Today, I am making this presentation as a member of the Executive Advisory Council of the California Commission on Industrial Innovation.

I am honored to participate in these hearings on the needs of American youth for increased technical education. The Commission on Industrial Innovation focused a great deal of its attention on this issue--devoting 32 of its 50 recommendations to education and job training. I will briefly summarize some of our findings:

--A "Sputnik-like" push promoting math, science, engineering and computer and high-technology job-training is critical to maintaining the growth of our economy. Unlike heavy manufacturing industries, the information technology sectors depend upon the intelligence and skills of its inventors and employees for success.

--The Information Revolution will affect millions of workers, both those who will work in the technology industries, and those whose jobs will be replaced by the new technologies. Business Week, for example, estimates that 45 million existing jobs in the United States will either disappear or become dramatically changed by the year 2000 as a result of the Information Revolution.

--The challenge of preparing citizens for life and work in an increasingly technological society will require investments by both federal and state governments, as well as the involvement of the private sector. The Commission called on the federal government to launch an effort similar to the National Defense Education Act, and endorses in principle the Perkins American Defense Education Act (HR 6674).

--Our youth must be required to take an increased amount of math, science and computer studies to prepare them for the future. Private industry can help in this effort through the provision of computer hardware and software, industry sites for supplemental teaching, and serving as teachers or trainers of teacher in new technologies.

--Any efforts to train new workers or upgrade train displaced workers requires the active involvement of the private sector to assure that training is related to future employment.

I have attached a copy of the report of the Commission on Industrial Innovation which lists thirty-two recommendations in support of technical education and job training.

WINNING TECHNOLOGIES

A New Industrial Strategy for California and the Nation

Executive Summary of the Report of the
California Commission on Industrial Innovation

For release:
September 2, 1982

EXECUTIVE ORDER #B-91-81

excerpts

The continued prosperity of California depends upon our fundamental reordering of priorities. The challenge of foreign competition and domestic industrial obsolescence requires that our genius for technological innovation become the guiding concept of the next decade.

California is strategically positioned to take advantage of technological advances in electronics, communications, aerospace, agriculture, and genetic sciences. Such technological advances will be a major benefit to all California industries. These benefits can best be realized through the creation of a new partnership between business, labor, academia, and government. This partnership can both advance and serve basic human values and enhance economic productivity....

A California Commission on Industrial Innovation is hereby established in the Governor's Office...The Commission shall provide a forum for discussion, debate, and policy guidance for the Governor and the Legislature on the role of technological innovation in maintaining California's leadership in the national economy and in retaining its international competitive position....

Governor of California
November 17, 1981

If you would like to receive the full report of the California Commission on Industrial Innovation, please call (916) 324-0401 or write Office of the Governor, State Capitol, Sacramento, CA 95814

WINNING TECHNOLOGIES

A New Industrial Strategy for California and the Nation

TABLE OF RECOMMENDATIONS

Industrial Strategies for Innovation

1. The California Commission on Industrial Innovation calls for the United States and California to develop national and state industrial strategies, aimed at accelerating the invention and utilization of winning technologies.

Investment for Innovation

2. The United States Congress should pass the Reciprocal Trade and Investment Act of 1982.

3. The President should aggressively negotiate lower trade barriers for high-technology products through the General Agreement on Tariffs and Trade (GATT).

4. The United States should expand the incremental research and development tax credit.

5. The United States should enact an antitrust exemption for joint research by high-technology companies.

6. California should establish antitrust exemptions for research and development cooperative ventures.

7. The United States should restore budget cuts in research in such critical areas as the National Institutes of Health, the National Science Foundation, and the national laboratories of the Department of Energy and NASA.

8. The United States should move toward the complete elimination of taxation of long-term capital gains. As a first step, the government should eliminate capital gains tax on investments in new companies, while taxing gains from investment in nonproductive investment as ordinary income, as has been legislated in California.

9. The United states should allow corporations, at their option, to write off equipment at the rate at which it becomes obsolete if this would result in faster depreciation than current schedules permit.

10. The United States should create financial free trade zones to attract foreign investment.

11. California should bring its treatment of incentive stock options and employee stock ownership plans into conformity with recent federal changes.

12. The United States should redirect policies and increase support for the Export-Import Bank to assist U.S. businesses.in effectively meeting unfair foreign competition.

13. States should enact pension fund flexibility to invest in innovation, as called for in Proposition 6 on the November 1982 ballot in California.

14. The United States should encourage investment in existing U.S.-based growth technologies targeted by government policies of our major industrialized trading partners.

Education and Job Training for Innovation

15. The United States should mobilize national resources to support math, science, computer, engineering and high-technology vocational education, as was done through the National Defense Education Act in the 1950s.

16. University and community college governing boards should raise entrance requirements in math, science and computer studies.

17. School boards should raise standards required for graduation from high school to at least three years of math and two years of science, including at least one semester of computer studies.

18. Private industry should extend support for summer study by students in math, science and computer studies.

19. California should include science and computer studies in statewide or local standard elementary and secondary school achievement tests.

20. State universities should train guidance counsellors to encourage students to take math, science and computer courses, especially women and minorities.

21. California should reorient existing math and science achievement tests to stress problem-solving and not rote computation.

22. The United States and California should match funds with private industry to develop new curricula using new technologies like videos and computers.

23. Post-secondary education should expand the number of course offerings in math, science and computers available to secondary school students.

24. The U.S. Congress should pass legislation offering the same tax benefits for donations of computers to elementary and high schools as now exist for donations to universities.

25. California should promote the development of new computer software to expand computer education for interactive learning.

26. Until computers become more common, California should expose students to computers through mobile vans such as those sponsored by the Industry Education Council of California.

27. California should encourage school districts to form regional high-tech high schools which pool trained teachers, equipment and curricula.

28. School boards should offer teacher income supplements to math, science and computer teachers, based on what such skills are worth in the private sector.

29. Private industry should introduce recognition incentives for superior teachers. Universities should also recognize outstanding teachers.

30. The private sector should offer the use of employees as part-time teachers.

31. Private industry should provide employees to train teachers in math, science, and computer studies, and provide industry sites for hands-on computer training.

32. Universities and State Colleges should increase their commitment to math, science, and computer education.

33. State and federal governments could fund incentives in the form of teacher education scholarships to attract teachers into math, science and computer studies.

34. Private industry could also hire high school math and science teachers during the summer session, as a way to supplement their income and to gain upgrade training in new technologies.

35. School Boards should provide opportunities for all existing teachers to take training supplements in computer-aided education.

36. The State and federal governments should jointly fund inservice retraining for teachers in math and science, especially those with emergency credentials, through

math/science computer institutes.

37. The United States and California should increase financial support to Schools of Engineering, Computer Science and related fields, so as to expand their capacity to produce qualified graduates.

38. The United States should not use the immigration laws to restrict the ability of foreign nations to work as engineers for U.S. companies or to serve as engineering faculty.

39. California should encourage the formation of university/industry research parks and expand other joint research efforts like MICRO, already established here, as a means of attracting new scientists and professor to the State.

40. California should encourage universities to revise patent policies to enhance industry cooperation.

41. The United States and state governments should encourage vocational programs to involve as much on-the-job training and employer participaton as possible.

42. California should place a high priority on the development of vocational training programs in new and emerging technologies.

43. The private sector should establish Business/Labor councils to review existing programs, develop new ones, and take other actions to promote effective job-training.

44. The private sector should offer industry sites, equipment and employees to serve as faculty to the community colleges for job-training programs.

45. California should make a comprehensive effort to retrain existing teachers for the new skills of the 1980s.

46. The U.S. and California should make special efforts to develop effective job-training programs for displaced workers.

Employee-Management Productivity for Innovation

48. California should establish Tripartite Boards to promote increased worker participation and productivity.

49. California should set up a clearinghouse to provide technical assistance and information to public and private sector efforts to increase workplace productivity.

50. California should encourage the development of employee stock ownership plans, and incentive stock option proposals for both workers and managers.

III. EDUCATION AND JOB TRAINING FOR INNOVATION IN THE 1980s

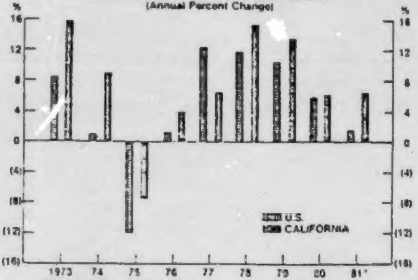
The California Commission on Industrial Innovation believes a "Sputnik-like" push promoting math, science, engineering, computer and high-technology vocational education is critical to rebuilding our economy in the 1980s. Such an investment in people is necessary not only to have the trained workforce necessary to spur innovation, but also to produce a citizenry able to enjoy it benefits. Unlike other industries which rely on cheap energy and plentiful natural resources, information technology sectors depend upon the intelligence and skills of its inventors and employees.

The need for such an investment in education and job training is dramatized by two factors: the large number of jobs which will be affected by the new technologies, and the jobs which will disappear as a result of modernization.

Our first need will be to educate millions of new workers in technical, engineering and computer science fields. The Bureau of Labor Statistics reports that the greatest job growth in the 1980s will be in such careers as computer programming and electrical engineering.

We will also need to provide more sophisticated education for millions more white collar and service workers. The Xerox Corporation, for example, estimates that 60 million U.S. workers will be linked to electronic work stations of computers, video screens and telephone lines by 1990. Thirty-six million of these workers will need to be literate in programming and other basic computer functions.

In California, this will especially be the case. Crocker Bank in a recent forecast predicted that growth in the California electronics industry will be 58%, almost double the growth in electronics nationally.



EMPLOYMENT IN THE ELECTRONICS INDUSTRY
(Annual Percent Change)

*Based on First Quarter data only.

Source: Crocker Bank

As the new technologies spread into more mature sectors, many existing jobs will either disappear or significantly change. Business Week magazine estimates that 45 million existing jobs in the United States will become obsolete or dramatically change during the next two decades. In California, recent plant closings in fields such as auto assembly are examples of this nationwide trend.

The new jobs which will be created by the information technologies will demand greater technological sophistication than ever before. As high-technology becomes crucial to productivity increases in traditional fields from nursing to textiles to clerical work, training in these occupations will require computer literacy.

As all those who work in the new technology industries know, the key to our economic health will be the knowledge and ability of our people. As Governor Edmund G. Brown Jr. stated in an editorial in the San Jose Mercury, "California's most important challenge today is to retool its educational systems to meet the demands of an economy where less becomes more through the efficiency of high technology. Our goal must be to ensure that Californians are trained and educated for the work environment that is now being improved and radically restructured by the new information technologies."

Unfortunately, current fiscal realities have led to a declining revenue base for our education system. As Stanford University professor Mike Kirst noted in a report prepared for the Commission,

> "At a time when the requirements for employment, the military and citizenship are increasingly technical, the capacity of public education to provide this additional preparation is decreasing. Declining time in school, shortages of math and science teachers, outmoded texts, inadequate technical equipment, unclear academic standards and a declining financial base are combining to prevent California's educational system from responding to the demand for technical education.
>
> "The federal government is decimating its support and leadership, while state treasuries are being drained by the recession. Private sector leadership and funding has focused only on the apex of the system -- prestige universities and engineering schools. Local agencies are wringing their hands, but are unable to reverse the negative tide."

The Commissioners echoed these sentiments. Commission Robert Marr, Public Relations Director for the Operation Engineers Local #3 in San Francisco, summed up the Commission's feelings when he stated:

"I believe that the most important finding of the Commission has been to demonstrate a definite, dire need to rearrange our educational system, to provide people with skills for the jobs that are coming.

"Everyone on the Commission is in consensus on this. But the question is, how are we going to fund the thing?

"I think when you really get down to it, people don't mind paying higher taxes for education, as long as it's demonstrated that the final product is worth it."

The Commission agreed that additional resources needed to be pumped into California's educational system from elementary and high school through the community college system to the universities. These resources should come from a combination of new revenues from the State and Federal governments and from a reallocation of resources toward technical education within existing budgets. The Commission agreed that the involvement of the Federal government in education was needed, although few believed that additional resources would be forthcoming.

Recommendation #15. The U.S. should mobilize national resources to support math, science, computer, engineering and high technology vocational education, as was done through the National Defense Education Act in the 1950s.

The Commission calls upon the federal government to mobilize a national push for upgrading technical education, as was done in the 1950s. Unlike the 1950s, however, the Commission feels that the actual initiative and responsibility for developing education initiatives should rest with state and local governments, with Washington, D..C. serving primarily as a source of "technology education block grant" funding.

The Commission endorses in concept a number of proposals that have been made to accomplish this goal, including Governor Brown's proposed National Economic Security Education Act, and the proposed American Defense Education Act currently before Congress, although it reserves judgment on final details until they have been completed.

The Commission believes that such national action could provide funding for the elementary and high school, university and vocational programs outlined below.

Commissioners emphasize, however, that such funding should accompany major efforts by the education system to use existing funds more wisely. Federal action is needed to help fund reform, not merely support the status quo.

A. Elementary and Secondary Education

The California Commission on Industrial Innovation believes that one of the highest priorities must be the fostering of general "technological literacy" for all students in elementary and secondary schools. To remain internationally competitive, U.S. students must meet the highest standards in both the quantity and quality of math, science, and computer studies pursued.

The Commission endorses calls by Governor Brown, the University of California regents, the Community College trustees, the State Board of Education and others for raising math, science, and computer course requirements for graduation from high school and entrance to post-secondary education.

In California, less than one-third of all high school graduates have taken three years of math and two years of science. As seen in the table below, Californians trail the nation in the number of math and science courses studied.

PERCENTAGE OF 1979-80 HIGH SCHOOL SENIORS
WHO HAD TAKEN SPECIFIC NUMBERS OF YEARS OF
MATHEMATICS AND SCIENCE COURSE WORK

Number of Years of course work	Mathematics		Science	
	In the Nation	In California	In the Nation	In California
One year or more	92.2	90.3	89.2	87.2
Two years or	64.9	58.2	51.5	41.3
Three years or more	31.4	25.6	21.6	13.3

Source: National Center for Educational Statistics. As cited in California State Department of Education, 1981.

Recommendation #16. University and community college governing boards should raise entrance requirements in math, science and computer studies.

The Commission endorses the kind of action taken by the University of California which recently passed standards requiring all entering students to have at least three years of math and two years of science studies. The Regents have also endorsed the Governor's call to consider raising standards even higher, to four years of math, and three years of science, including at least one semester of computer studies.

Recommendation #17. School boards should raise standards required for graduation from high school to at least three years of math and two years of science, including at least one semester of computer studies.

The Commission endorses the recent action by the State Board of Education to urge all California school boards to require at least three years of math and two years of science, including one semester of computer study for all high school graduates. In order to implement this resolution, the State Department of Education must aid school districts in the development of math and science courses for the non-college bound student.

Recommendation #18. Private industry should extend support for summer study by students in math, science, and computer studies.

Particular attention should be given to efforts to encourage minority students and women to pursue math, science and computer studies, as done through the MESA and EQUALS programs in California.

Recommendation #19. California should include science and computer studies in statewide or local standard elementary and secondary school achievement tests.

At present, only math is tested on statewide or local standard elementary and secondary school achievement tests. State universities and colleges should also be encouraged to use these tests as a regular part of their admissions process.

Recommendation #20. State universities should train guidance counsellors to encourage students to take math, science and computer courses, especially women and minorities.

Guidance counsellors should be provided with up-to-date employment trend data to assist them in guiding students. Women and minorities, who traditionally shy away from technical vocations and engineering, should be particularly encouraged to enter these growth fields.

Recommendation #21. California should reorient existing math and science achievement tests to stress problem-solving and not rote computation.

The advent of the computer age will mean that problem-solving will become that much more important. Computers will provide access to information which previously was memorized by students.

Implementing these higher math and science standards will not be an easy task. Some of the obstacles include outmoded curricula that lack general introductory courses on technology, physical sciences and math, shortages of qualified math and science teachers, and the lack of computer-aided instructional materials in schools. The Commission calls on the public and private sectors to work together to fill these gaps. The following recommendations are proposed solutions to the "technology literacy gap" of our students:

i. Curriculum and Computer-Aided Instruction

Commissioners felt strongly that public schools need to reexamine existing curricula with an eye toward the new technologies. As Commissioner Regis McKenna, Chairman of Regis McKenna, Inc., clearly stated, "We must begin to grow a generation of computer literate children. And we must begin at the elementary school level."

Recommendation #22. The U.S. and California should match funds with private industry to develop new curricula using new technologies like videos and computers.

The CCII education subcommittee has reported that the development of a completely new curriculum has historically cost between $5 and $10 million, and that adaptation of existing curricula or development of a single course text could be done for less than $3 million.

Recommendation #23. Post-secondary institutions should expand the number of course offerings in math, science and computers available to secondary school students.

The estimated cost for 1,000 students to take science or math extension courses at each of 19 state universities would be $2 million.

Recommendation #24. The U.S. Congress should pass legislation offering the same tax benefits for donations of computers to elementary and high schools as now exist for donations to universities.

Specifically, Congress should pass the Technology Education Act of 1982, currently before it, which would create a tax credit for "computer and other technologically sophisticated equipment" to elementary and high schools.

Recommendation #25. California should promote the development of new computer software to expand computer education for interactive learning.

Models for the kind of action that needs to be taken include Minnesota, which has the nation's most extensive program to develop computer software, through the Minnesota Education and Computer Consortium (MECC). The Governor's "Investment in People" program in California makes funds available for 15 Teacher Education and Computer Centers around California to evaluate software for teachers, and establishes a software clearinghouse. Funds are also provided to institutions and individuals developing "exemplary" software programs.

Recommendation #26. Until computers become more common, California should expose students to computers through mobile vans such as those sponsored by the Industry Education Council of California.

Recommendation #27. California should encourage school districts to form regional high-tech high schools which pool trained teachers, equipment and curricula.

One low-cost alternative to individual development of curricula, computer purchases and the hiring of computer teachers is the formation of regional schools. The Los Gatos and Fremont Union High School Districts have begun such a collaborative venture to form an Institute for Computer Technology in Sunnyvale.

ii. Teacher Recruitment, Retention and Retraining

One of the major obstacles to bridging the "technology literacy gap" is the shortage of qualified math and science teachers. As illustrated in the accompanying table, the number of new math and science teachers has declined dramatically since 1971. Several trends contribute to this shortage: (a) increasing numbers of teachers are reaching retirement age; (b) the "reserve army" of housewives with teaching credentials no longer exists; (c) a declining number of college students are pursuing teaching careers in math and science; (d) an increasing number of teachers are being lured away from the profession by high industry salaries; and (e) the shortage of in-service training programs has resulted in the decline in quality of math and science teaching.

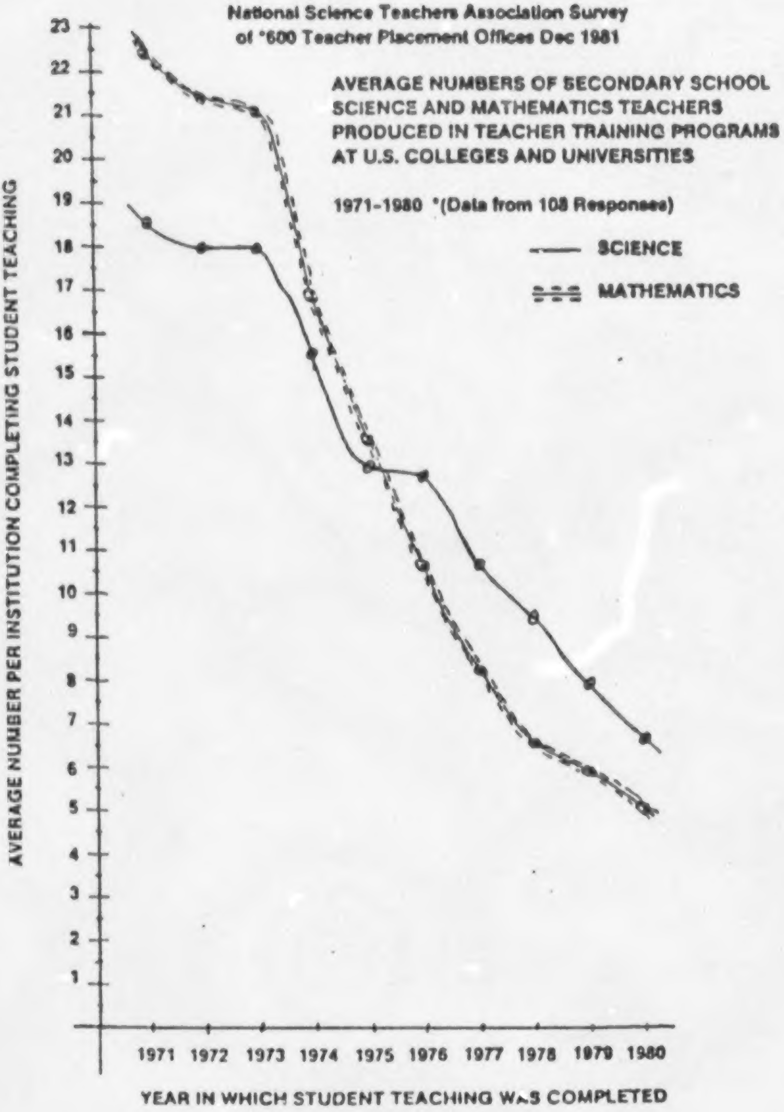
The Commission recommends that the public and private sector work together to bridge the gap in math and science teachers in the following ways:

Recommendation #28. School boards should offer teacher income supplements to math, science and computer teachers, based on what such skills are worth in the private sector.

Income supplementation could occur through summer employment in industry and sabbatical leaves. The estimated cost of 13-week summer work supplements for one-tenth of California's math and science teachers would range from $18 million to $32 million, depending on whether summer work was paid according to teaching or industry salary schedules.

Recommendation #29. Private industry should introduce recognition incentives for superior teachers. Universities should also recognize outstanding teachers.

Private industry could participate in such a program by extending annual recognition bonuses to superior teachers and providing fellowships for superior classroom teachers to receive additional training. The CCII education subcommittee found that it would cost approximately $4 million a year for 10% of all California math and science teachers to receive a $1500 recognition bonus annually. The University could also annually recognize superior teachers through some kind of award.



National Science Teachers Association Survey
of *600 Teacher Placement Offices Dec 1981

AVERAGE NUMBERS OF SECONDARY SCHOOL SCIENCE AND MATHEMATICS TEACHERS PRODUCED IN TEACHER TRAINING PROGRAMS AT U.S. COLLEGES AND UNIVERSITIES

1971-1980 *(Data from 108 Responses)

Recommendation #30. The private sector should offer the use of employees as part-time teachers.

The estimated cost would be approximately half of each employee's annual salary, in donated time. A CCII Education Subcommittee report estimated that placing one half-time industry/ teacher in each California secondary school would cost about $3 million a year.

Recommendation #31. Private industry should provide employees to train teachers in math, science and computer studies, and provide industry sites for hands-on computer training.

The private sector might be better suited as trainers of teachers, than as teachers themselves. Industry in this capacity could provide equipment, classroom sites and personnel to upgrade train teachers.

Recommendation #32. Universities and State Colleges should increase their commitment to math, science, and computer teacher education.

State colleges and universities should encourage talented students to enter the teaching profession in math, science and computer studies, devote more time and resources to training teachers in these fields, target the introduction of computers for interactive learning, and become more active in working with public schools to develop new curricula.

Recommendation #33. State and federal governments could fund incentives in the form of teacher education scholarships to attract teachers into math, science and computer studies.

Such scholarships might be offered in exchange for a commitment to remain in the field for 3-5 years. It is estimated that each $1,000 scholarship would cost about $6 million.

Recommendation #34. Private industry could also hire high school math and science teachers during the summer session, as a way to supplement their income and to gain upgrade training in new technologies.

While the summer employment of teachers by industry has been a more common practice at the university level, some companies, such as Hewlett-Packard, have also established similar programs for high school teachers.

Recommendation #35. School Boards should provide opportunities for all existing teachers to take training supplements in computer-aided education.

Such actions could follow the model recently established in California, for the 1982-83 school year, as the result of funding provided under the Governor's "Investment in People" program. California is establishing 15 Teacher Education and Computer Centers around the state which are charged, in part, with establishing teacher training programs for promoting interactive learning with computers.

Recommendation #36. The State and Federal governments should jointly fund inservice training for teachers in math and science, especially those with emergency credentials, through the establishment of math/science/computer institutes.

Such programs should be developed and underwritten by the federal and state governments, state university and private industry.

California has taken the lead in setting up such a program through its 15 TEC centers, and separate funding provided to pay for school year release-time and summer stipends for teachers pursuing retraining in math, science and computer studies.

B. University Engineering and Computer Science Education

Commission members, particularly those representing high technology firms, feel strongly that a steady supply of engineers, computer scientists and other top professionals is critical for the U.S. to maintain its economic leadership in the 1980s.

Commissioner Richard Atkinson summarized the sentiment of the Commission when he stated:

"The key to our high technology future is our universities, both in producing the basic research leading to innovation, and generating the highly trained people who provide the basis for industrial applications.

"But if we compare the great universities in the United States with corresponding institutions in Germany, Japan and England, it's clear that our support of higher education is inadequate. Equipment and facilities available to university-based scientists today are far inferior to those available in nations with which we compete. Even the state of California, with one of the greatest public and private university systems in the world, imports more than half the engineers we need from other states.

"We will need a far greater national commitment to our research universities to maintain our economic strength in the 1980s."

Commissioners report that the United States faces a critical shortage of electrical engineers, computer scientists, and other highly trained professionals during the 1980s. They emphasize that it is projected that California will need well over 76,000 new engineers over the next decade. Some 50,000 of these will be needed by expanding high-tech industries. Although the number of California graduates with BAs in engineering has been increasing at a rate of 9 percent a year, we only graduated around 5,000 in 1980. Clearly, colleges and universities must place unfaltering priority on the continued expansion of engineering schools if we are to have any hope of meeting emerging demand.

Commissioners stress that this nation cannot keep its technological leadership indefinitely if other nations continue to produce more engineers per capita than we.

The California Commission on Industrial Innovation calls for a concerted national push to increase the output of engineers and computer scientists from our universities, and opposes any efforts to reduce the ability of foreign nationals to work in American firms in these critical fields.

Recommendation #37. The U.S. and California should increase financial support to Schools of Engineering, Computer Science and related fields, so as to expand their capacity to produce qualified graduates.

The CCII prioritizes providing professors with income and conditions competitive with the private sector. The CCII supports increasing:

- -- faculty research grants and summer instructional opportunities;
- -- opportunities for faculty graduate and post-Doctoral training;
- -- joint faculty appointments to universities and private companies for consulting and research, particularly during the summer;
- -- the endowment of Chairs by private companies;
- -- the availability of up-to-date instructional and research equipment through public sector donations and university equipment purchases.

The CCII also supports calls for increasing facilities so as to allow engineering schools to increase enrollment.

Recommendation #38. The United States should not use the immigration laws to restrict the ability of foreign nationals to work as engineers for U.S. companies, or to serve as engineering faculty.

The CCII strongly opposes current attempts in Congress to amend the immigration laws to require foreign graduates from U.S. schools to return home and apply for re-entrance to the U.S. Qualified graduates who can find jobs should be allowed to take them. As long as a shortage of American engineers exists, such restrictions would only further weaken the ability of our universities and industry to innovate.

Recommendation #39. California should encourage the formation of university/industry research parks and expand other joint research efforts like MICRO, already established here, as a means of attracting new scientists and professors to the state.

Engineering faculty and researchers tend to be attracted to and stay at universities with up-to-date equipment, performing state-of-the-art research. The formation of research parks and other joint projects with industry thus attracts individuals to the universities.

These research parks would be collaborative efforts between small business and universities to fund basic and applied research. They could be initially funded by industrial revenue bonds, under existing authorities, then subsequently financed by leases and royalties on products resulting from the research.

The California Legislature should also expand funding for the University of California's MICRO project, a collaborative effort to support basic research in microelectronics initiated two years ago. Similar programs could be established in the area of biotechnology.

Recommendation #40. California should encourage universities to revise patent policies to enhance industry cooperation.

Again, any impediment to industry involvement with the university serves to drive away faculty and top-notch researchers. Existing patent policies discourage industries from participating in joint research because they must share the results with all other companies. Recognizing the public nature of inventions discovered due to public funds, and the need for the contributing company to have some proprietary rights to an invention, current patent policies could be rewritten.

C. Community Colleges and Job Training Programs

The California Commission on Industrial Innovation notes that the modernization of our economy requires a steady supply of skilled workers, in both new and old industries. The community college system and a variety of job training programs must play critical roles in ensuring that our nation's vocational training provides graduates with the skills necessary for the jobs of the future.

The Commission stresses the key role that private industry must play in designing and developing vocational education programs.

Commissioner Don Vial, Director of the California Department of Industrial Relations, has explained:

"The key to effective vocational training in the 1980s is for industry to define its needs -- whether for entry or upgrade programs, whether for classroom or on-the-job training. The vocational education system should then respond to what industry needs, provided industry is willing to be up front with its own investments in skill development and human capital. The mutual reinforcement of public and private investment in human capital is best served through employment-based training, as in apprenticeships and CWETA-type programs.

"The problem today is that the state spends several billion dollars a year on vocational education in ways that support existing programs in community colleges or high schools. These programs may or may not be geared to industry needs, may or may not be actually preparing students to find jobs in the marketplace."

To meet these needs, the Commission feels this nation must make an unprecedented commitment to job training with a future, built around the following principles:

(1) Employment-based training. Training programs should be as employment-based as possible, with employers participating in the design of vocational programs. Training programs should also attempt to secure prior commitments from employers to hire graduates upon completion of the training, and should involve as much on-the-job training as possible.

(2) New technology training. As much as possible, training should emphasize competencies in the new technologies, from computer use in general, to computer-aided design and manufacture, to robotics.

(3) Lifelong training. We need a new commitment to providing adults with the opportunity to learn and relearn new skills. As much as possible, planning should occur before displacement to ensure that workers are provided with training in new skills as they are displaced from their previous occupations. Society should see such training as an economic investment, and retraining should be seen as a public responsibility, not a burden to be borne by the displaced worker alone.

Following these principles, the California Commission on Industrial Innovation calls for a major effort by federal and state governments, and the private sector, to provide effective job-training for the 1980s.

Recommendation #41. The United States and state governments should encourage vocational programs to involve as much on-the-job training and employer participation as possible.

Government funding of vocational programs should require evidence that training programs are in fact leading to private and public sector employment, that employers are involved in the design and execution of the programs, and that as much on-the-job training is involved as is feasible. Incentives should also be made available to upgrade apprenticeship training.

Programs should be modeled after California's Worksite Education and Training Act (CWETA) program, which meets these criteria.

Recommendation #42. California should place a high priority on the development of vocational training programs in new and emerging technologies.

Special efforts are needed to ensure that community colleges, high schools and other providers of job training are in fact offering programs in new and emerging technologies. Federal and state funding should require that such courses be offered, and should also encourage the creation of comprehensive technical centers offering coordinated training in high technology fields.

Models to be looked at would include two new Skills Centers in the process of being established in California, in the community college districts of Los Angeles and San Jose.

Recommendation #43. The private sector should establish Business/Labor Councils to review existing programs, develop new ones, and take other actions to promote effective job-training.

Business and labor groups should establish bodies funded independently from the educational system itself to review existing vocational education programs, to ensure that they are in fact training students for jobs that exist in the marketplace. Community Colleges and Job Training Programs should work closely with "Business-Labor Councils" to identify obsolete courses, prioritize the updating of continuing programs, and design new ones where necessary. The private sector should also play a more active role in existing curriculum advisory committees, which should be given more power to influence existing curriculum.

Recommendation #44. The private sector should offer industry sites, equipment and employees to serve as faculty to the community colleges for job-training programs.

Business can help improve vocational training by providing instructors, offering lectures and visits by prospective employers, using business sites as instructional resources, and donating equipment to training programs, and offering student "coop" opportunities to work part-time and during the summers.

Recommendation #45. California should make a comprehensive effort to retrain existing teachers for the new skills of the 1980s.

Government, the universities and private industry should join together to develop training programs for vocational teachers, to upgrade their skills for the 1980s. Programs should be modeled after efforts to retrain high school teachers in math, science and computer studies.

Recommendation #46. The U.S. and California should make special efforts to develop effective job-training programs for displaced workers.

Special programs must be targeted to the needs of displaced workers. Actions could follow the model of the Governor's 1982-83 "Investment in People" initiative in California for displaced workers, which will see funds expended to set up Reemployment Training Centers in regions affected by plant-closings, as well as other funds allocated to the community colleges to set up programs targeted to the needs of displaced workers.

Recommendation #47. The U.S. and California should take major fiscal actions designed to allow displaced workers "portable benefits" to be used in obtaining job retraining.

Federal and state budget revenues will not be adequate in the 1980s to fund the tens of millions of American workers who will need retraining. Instead, existing benefits systems need to be adjusted to allow workers to use funds for retraining. The California State Legislature, for example, is considering a proposal to allow surplus unemployment insurance funds to be used to fund retraining. Others have proposed that incentives be given workers to use IRA funds for retraining, or that employers and/or workers be given special tax incentives for retraining.

Whatever method or set of methods is chosen, however, the CCII recommends that urgent attention be given to this problem.

Mr. **Tirana**. I would like to speak from my personal interest. I was chairman of Technics, a small manufacturing company, which we founded in Virginia approximately 10 years ago with zero capital and a garage next to a laundramat.

I became vice chairman this June, demoting myself, when we decided that we had to move the company to California. We were there anyhow.

But we found that a high technology manufacturing company could not exist in the environment in the Washington, D.C., metropolitan area.

Education and the availability of a work force capable of functioning in high technology and of vendor support does not exist in this area.

It does exist in California. It exists in the Minneapolis-St. Paul area. It exists in the route 128 area outside of Boston.

Education and an environment in which education is fostered is critical to the success of high technology.

I felt sorry at the decision which economically we had to take. We started here. We opened a facility in a garage in California, San Jose, in 1975. We opened a facility in Munich, West Germany, in 1977.

We opened a little facility southwest of Yokohama City in 1982 and were doing fairly well in Japan.

Having served on the board of education in the District of Columbia for 4 years, to make a decision that we had to move out of this area was painful.

California has an environment which has attracted engineers and has attracted entrepreneurs and businessmen. I am quite sure that at the heart of it was the California State system of education—elementary and secondary, but particularly the junior colleges and university systems.

I am sorry to see the deemphasis that has taken place in the last decade. Minnesota, obviously, has the same high political and community emphasis on education and high technology and has been able to function and blossom in that State.

There is no question that national government leadership is required. When one thinks of high technology growth, you have to ask: Where did it come from?

A large portion of that is from the Apollo space effort begun by the Federal Government which the Federal Government took the leadership role.

My own little business, which makes a peculiar kind of machine called an ion-mill, which is nothing more than the ion-thruster which used to propel the Apollo spacecraft.

It is stuck into a vacuum chamber where we sandblast semiconductor wafters or thin-head recording heads. Our most giant ion-mill is now being installed in magnetic peripherals in Minneapolis. I hope the installation will be complete tomorrow.

Government has an active role. Technology is way ahead. What is lagging is the political system and political leadership. The problem exists more in the executive branch and in the Congress, I think, than it does within the school systems as such. Political leadership has to keep up with technology. There is no limit to technology. The limits seem to be more political at the moment.

Thank you.

Mr. **Erdahl**. Thank you very much.

We will go to the final witness on the panel, Bonnie Van Dorn, director, Association of Science and Technology Centers here in Washington, D.C.

Ms. Van Dorn, please proceed.

STATEMENT OF BONNIE VAN DORN, DIRECTOR, ASSOCIATION OF SCIENCE AND TECHNOLOGY CENTERS, APPEARING ON BEHALF OF THE EXPLORATORIUM, SAN FRANCISCO, CALIF.

Ms. **Van Dorn**. Thank you, Mr. Chairman.

I appreciate the invitation of the subcommittee to be able to speak today.

I direct a very small association that represents a very diverse membership. The Association of Science and Technology Centers is a nonprofit agency that represents science museums and related organizations throughout the world.

About 100 of our members are science centers within the United States and one of these is the Exploratorium in San Francisco, well known for its innovative exhibits and probably better known because of a recent Nova television program about it this past year.

I am here on behalf of Dr. Frank Oppenheimer and Dr. Ilan Chabay, the Executive Director and the Associate Director of the Exploratorium in San Francisco.

They regret that they were unable to be here today and asked that I deliver their testimony on their behalf.

We are grateful to the members of this subcommittee for the invitation and opportunity to contribute to the current hearings.

The focus of our testimony will be on the role that science museums can and do play in elementary and secondary level science and mathematics education.

Though we will primarily refer to the Exploratorium, many of its goals and programs are similar to those at other institutions in the United States and elsewhere. In these sense our point of view and experiences are representative of a broad range of large and small institutions.

Museums in general make essential contributions to public education, and science museums in particular contribute to elementary and secondary level science and mathematics education.

They, therefore, should be included in every instance in legislation dealing with the improvement of science education.

There are three special attributes of museums which make them unique and important places for learning. In the first place, they display the genuine article—original paintings, actual tools and ornaments of ancient cultures, or the operating phenomena of nature around which physics and biology are built.

This show of reality represents a basic honesty that has a surprisingly important effect on learning.

A reproduction of a painting does not stir the imagination or lie as deep in memory as does the original. Recreated gold jewelry of ancient Egypt or modern versions of a suit of armor do not have nearly the stirring effect on the museum visitor evoked by objects that actually were used in the past.

It is the same with scientific phenomena. In order to enable the visitors to have genuine and important experiences, they must be able to hold prisms, pieces of polaroid or lenses and see how they behave and also what are the limits of their properties.

Although animated films and models with lights showing flow patterns may be very clear, they do not have the impact of actual processes.

Furthermore, in all aspects of learning it is important for the learner to be able to modify and to change the situation enough to discover factors that impose limits on a particular kind of behavior.

Such interactions with reality, which can readily be set up and maintained in a science museum, play an extraordinary important role in the learning of science and mathematics.

Second, in addition to providing the imagination-stirring quality of the real object and the real experience, museums have an ability to present an overview of an entire field that is very difficult to achieve in more linear vehicles for learning such as a course which meets Monday, Wednesday, and Friday for 16 weeks, or even in films and books.

This overview, this putting together and allowing the viewer to discover the possibility of connections, not only within one domain such as physics, but even between different discipline such as physics and biology or science and art, is a strongly motivating and reassuring part of learning.

A third remarkable property of museums lies in the way that, while presenting such a broad overview, museums can at the same time provide multiple examples and great detail about each segment of the broad picture.

In the Exploratorium, for example, although we connect and interrelate many different kinds of reflection—the reflection of sound, of water, of pulses in ropes and of light—we also have over a dozen or so exhibits which specifically show the reflection of light from mirrors.

These exhibits are a part of our collection of 90 exhibits on the behavior of light that in turn connect with 70 other exhibits on vision, among which there are at least 8 exhibits that show in detail the effects of lateral inhibition in the eye.

In each of the domains or subject areas the visitor can become familiar with a particular concept because it is represented in a great variety of phenomenological contexts.

Not all science museums are organized to show quite as explicitly as does the Exploratorium the way that multiple detailed examples can combine with broadly extended threads to illustrate ideas.

But all of them do nevertheless to some degree have these three properties. In all of them visitors can play with the real experiments and explore the real phenomena; they can get a broad overview of interlocking aspects of science; they can focus in on a multiplicity of details in a particular corner that interests them.

Seeing the sights of nature, or art, or history is one of the most effective precurses and motivating forces for learning. As specially arranged avenues for updated sightseeing, museums therefore perform a unique and vital educational role, supplementing schools and universities.

Educators and faculties have been aware of the responsibility they have for not merely training their students to be good at something or to become inventive or thoughtful, but also to survey the broad fields of culture and achievement.

But schools and universities are not designed to provide this kind of learning. Classroom sightseeing resembles sightseeing on a train—courses rush to their destination so that passengers can make their connections.

The great vistas that rush by, the people and towns along the way never become part of the viewer's experience. Blackboard lectures tend to provide a seriatim presentation of material, like the nonstoppable two dimensional type of education epitomized in films and television programs.

A major difference between the school environment and the museum is that in the museum the choices of direction and duration of observation and study are not externally determined.

The classroom situation is essential to many types of learning, especially those which involve intellectual competence, as in mathematics, physics, philosophy, or economics.

But it has not been designed to provide the general kind of sightseeing the community as a whole and the student in particular needs and demands.

The Exploratorium is a museum of science and human perception which stresses the role of art, music, play, and individual exploration in the learning of science.

Many who come to the museum to see the art or to study the exhibits on perception find themselves drawn to and fascinated by the scientific exhibits.

The beauty of the art and the aesthetics of the science involve people in learning science, even when that was not their reason for visiting.

The Exploratorium plays a variety of roles in the San Francisco Bay area community and beyond. If has strong connections to local schools at all levels, to which it offers a broad range of services and unique resources.

The Exploratorium was conceived and established because to a large extent students at all levels of learning, from elementary, high school, undergraduate college, and perhaps even through graduate school had negligible familiarity with the real scientific phenomena that they were studying in school.

Even most of the good teaching laboratories are not ones which enable students to explore how nature behaves but are the ones which emphasize verifying the calculations presented in the classroom.

They have relatively little impact on the building of intuition and the development of a sense of the overall coherence of a subject.

The attainment of excellence in the teaching of science involves providing students with more than can be provided in their normal classroom or lecture hall, and it certainly involves more than just the attainment of skill in problem solving.

In order to get the most out of training for a life in science, or for a life in an increasingly technologically complex society, students must develop a familiarity with an an intuition about the way nature behaves in a variety of contexts, and they must learn about the pathways and interconnections between many different types of phenomena.

A substantial part of the Exploratorium's efforts have been directed toward the development of programs which directly affect the quality of public education in science and mathematics.

Included in these services are a variety of classes in the Exploratorium and in schools for teachers as well as students, a lending library of exhibits for use in school classrooms as teaching tools, a program for training and employing high school students as explainers in the Exploratorium, a series of 2-week sessions to share ideas with interns from other institutions, and publications in the form of videotapes, a magazine, and textbook-like catalog.

Training teachers to make use of the exhibits in the Exploratorium benefits the teachers and students in several important ways.

The resources of the Exploratorium can be utilized by the teachers much more effectively if the teachers are first familiar with the wide range of phenomena exhibited and with the interrelationships between various exhibits.

This Exploratorium's lending library of small-scale exhibits and demonstration kits can be used by the teacher in the school environment to supplement the field trip experience.

An important component of the Exploratorium is the explainer program. This program employs about 30 high school students drawn from all area communities to run demonstrations on the museum floor and be available to help visitors manipulate and understand the exhibits.

Every 4 months a new group of explainers is hired and trained. The experience gained by the high school student through interacting with visitors, learing by explaining, and participating in the activities of the Exploratorium, often contributes substantially to the intellectual and emotional development of the students.

Field trips to the Exploratorium have been a significant part of the educational impact of the museum on the surrounding community.

These school-sponsored trips allow students to interact with any exhibits in the Exploratorium, to concentrate on one topic in one section of the museum, or to follow a written "pathway" of exhibits encompassing several facets of a particular phenomenon chosen by the teacher.

An experienced, college age explainer works with each group and provides explanations, demonstrations, and information for the teachers.

Field trips are scheduled at times when the museum is closed to the general public in order to insure the students maximum accessibility to all exhibits.

The students who come on class field trips invariably return with parents and friends. These students then become the teachers for their community.

Classes for the public are given at the Exploratorium. These classes are for all ages, from preschool through adult. Classes for elementary and secondary school age students cover such topics as optics, digital electronics, perception, computer graphics, and marine biology.

The essential aspects of these classes are that the students enjoy learning and learn most effectively by experimentation with the large and unique collection of exhibits and materials in the Exploratorium.

In addition to the classes organized by the Exploratorium staff, other organizations and teachers have conducted classes at the museum.

For example, a program of courses for MESA [mathematics, engineering, science achievement], a California-based organization designed to enrich the math and science education of minority high school students—was run very successfully during the summer.

Contributions of the Exploratorium to the education often extend well beyond the immediate geographic area. One such example of the effect of the Exploratorium's approach to learning was the creation of a "mini-Exploratorium" built by students in the classroom of their midwestern high school.

The project grew out of the enthusiastic response of two high school science teachers who visited the Exploratorium during a vacation.

Information and plans for the exhibits came from Exploratorium staff and from the students themselves. The Exploratorium publishes two volumes of a "cookbook" giving the details of construction and use of the museum exhibits. The Exploratorium cookbooks are in use all over the world.

In addition to welcoming its many visitors—500,000 a year of which about 95,000 are from States other than California, and 45,000 are from other countries—the Exploratorium conducts a series of 2-week long workshops for professional staff from institutions throughout the United States and the world.

These workshops allow the Exploratorium to disseminate the fundamental ideas of the museum and its exhibit concepts to other places and to share the ideas generated at the other institutions.

Videotapes and a magazine are being produced at the Exploratorium. These are focused on the observation of a particular type of phenomena or events evident around everyone and serve to stimulate observation, interest, and enjoyment.

Topics such as the physics of baseball, wave motion, light and shadows, and bubbles have been the central themes of some magazine issues.

Funding for these specific programs and for the operation of the Exploratorium as is the case for many museums is largely from corporate and individual donations, and foundation grants.

San Francisco hotel tax, California Arts Council funding, and grants from the National Endowment for the Arts, National Endowment for the Humanities, and the National Science Foundation have also played an important role in the support of the museum and its projects.

The support from NSF is no longer available in the context of educational programs. Recently the support for school field trips also has declined drastically.

The need for a comprehensive program of support for museums in their essential and unique role as resource centers for elementary and secondary school education in science and mathematics is crucial.

Inclusion of language authorizing support for museums in Federal legislation dealing with education in science and mathematics, such as is in H.R. 7135, but absent from H.R. 6674, could contribute substantially to the goal of strengthening the scientific literacy of the Nation.

The programs within the Exploratorium and outside its walls all carry forth the central idea of learning through direct interaction with an exhibit or phenomenon.

The immediacy of the observed effect, the ability to control variables, learn by experience, develop a physical intuition, enjoy the stimulation of discovery, and appreciate the interplay between art and science in illuminating nature are the essential elements of the process of education that museums such as the Exploratorium can contribute.

The Exploratorium and museums in general can serve as essential supplements to the process of education in science and mathematics.

They are marvelous resource centers for the schools and provide a great source of motivation for the students, teachers, and parents alike.

We have described the features and programs of the Exploratorium in some detail because we know them well. The features and programs are, however, characteristic of all the many science centers that have developed and are being established throughout the United States.

I would like to echo the testimony in that the Exploratorium in many ways is typical of many science museums. Of the science centers in our organization, over 95 percent of them have programs in existence where they are cooperating with schools.

Over two-thirds of their audiences are school children and the quality of the resources and the teaching staffs at these institutions mean that many of them are even offering college credit graduate courses in science education in cooperative relationship with local universities.

So, science centers, although they are a valuable resource in many cases are an underutilized resource as far as science and mathematics education is concerned.

Thank you.

Mr. ERDAHL. Thank you very much.

Let me make some observations, Ms. Van Dorn, about your testimony because at first I was not sure how it related to the other three members of the panel, but the more I listened the more persuaded I became that we will be looking for learning opportunities and settings other than the classroom.

Whether this might be in an intern-type situation or whether it might be in your laboratory, or maybe working as an intern with the school boards, there are a lot of different possibilities that are apart from learning in the regular classroom.

I think as we move ahead we have to see that these opportunities are made available and expanded rather than be curtailed.

That seems to be, I think, the pressure that we find ourselves under because of economic restraints.

I wonder if any of the other members of the panel would care to comment on the last testimony. It was a bit different but I think very useful.

Maybe you have a different impression of it than I have.

Mrs. **Carl**. I would like to comment on that and share with you the fact that in Houston we use our science museum and our magnet elementary schools.

One of our schools has the reputation of being the amusement school. Their final exam takes place at AstroWorld. They are actually involved in the physics and math involved in the amusement rides.

As an example, one of the questions is: At what point is a girl with long hair seen with her hair outstraight? When is it high and when is it at rest?

The youngsters are able to use the math that they have learned and the science experience to compute and really become aware of the scientific involvement.

That in itself has really increased the interest in mathematics for elementary youngsters in that particular school. It is now spreading from one to three schools that will be involved in the project for next year.

Mr. **Erdahl**. Thank you very much.

We have now been joined by Congressman Goodling of Pennsylvania.

We have heard some interesting testimony. We were just asking questions. Mr. Goodling has a long background not only as a Congressman but also as an educator and administrator. He may have questions later.

Let me start by asking Dr. Parent this. I guess this could be to any member of the panel as well.

As we talked in this whole area of bonuses and fees—and obviously, Mrs. Carl, that was a focus of your testimony today—seems to me sense that we could reward excellence and we should not tolerate mediocrity.

It seems that maybe our present system has it backward. We seem to almost reward mediocrity.

I guess the question I have is for Dr. Parent as one who works with the school boards. Maybe the reward system has been tried in Minnesota. I suppose it is similar in some ways to rewards we give at the university level of different designations for professors, associate professors, and so forth.

What type of resistance do you think we would get nationwide from teacher unions and others on this? There seems to be some of that in the Houston area.

Dr. **Parent**. Very high.

Mr. **Erdahl**. I thought you might say that. But why do you not elaborate a bit on that?

Dr. **Parent**. I believe it would be very difficult, particularly in States such as Texas. As Mrs. Carl mentioned, Texas does not have the so-called Culver legislation.

I think perhaps it would make a difference in States where there are contracts that have been bargained between the board and the teachers with structured salary grids.

It is not an insurmountable difficulty. I would not want to say doom and gloom it never will come to pass.

But I do think it would require a degree of give and take on both sides to allow the flexibility to change any salary grids.

Mr. **Erdahl**. That probably would be true. This is my observation as well. I am thinking of the distinction, Mrs. Carl, that in Texas you do not have a collective bargaining law. I guess Minnesota would have what we call a rather strong one.

In fact, I was a member of the Minnesota legislature some 20 years ago, when we were somewhat looked at as innovators, and maybe radicals because we passed the "meet and confer" law. We at least would meet and confer with the teachers.

That was a step toward stronger negotiating ability for the teachers. I do not think it is unreasonable that we have that.

Maybe I will turn to Mrs. Carl to follow up on that. Houston may be somewhat unique. We view that as a very wealthy place with oil and everything else.

Who pays for these bonuses? I am guessing that they must be between $3,000 and $4,000 if people put the several combinations together.

I think you mentioned later on that your maximum was $3,500. That is a significant bonus for someone receiving between $16,000 and $20,000.

Is this all paid by the local school districts? Or does the State kick in a certain share?

Mrs. **Carl**. The State has a minimum share that it contributes to all of the districts. But Houston has a very healthy economy. We also have a very large tax base.

One of the windfalls that we have is that the property in the city was an agreed value last year. The property that had not been looked at in some 25 years was upgraded as far as its value is concerned.

The school district in Houston sets its tax rate. The city merely collects the taxes for us. That, in a way, explains where the money comes from.

Mr. **Erdahl**. You mentioned in your tesimony that some survey had been taken among the 10,000 teachers in your district.

Some of the teachers that got the bonuses—I will call them incentives or rewards—liked the system. Some of the teachers did not like it.

Have you had any reaction or done any polling or testing on the children? Do they make a distinction and are they aware of rewards the teachers might get?

Mrs. **Carl**. I do not know that any testing or surveys have been made so far as the youngsters are concerned so far as the stipend is concerned.

But I know that the youngsters are very much aware of the fact—especially in the schools where there used to be the high rate of turnover—and that they are now a family. Their teachers have been there for 3 to 5 years without leaving, which was the experience we were having in the past.

Mr. **Erdahl**. I have another question for Mrs. Carl.

Is this system, or something like it, being used in other districts in Texas?

Mrs. **Carl**. Many other districts are making attempts at using this differential pay. Some are paying bonuses in advance of hiring or a one-time bonus or bonuses for 2 to 3 years and using that in a way of getting teachers to teach in these critical areas.

Some others are trying to do what we are doing. That is, as I said, to use a stipend to attract and hold these teachers.

But like Houston they are revealing it. There is the possibility that should this shortage ever right itself we would not need to do that. We would not be giving the stipends in those particular areas. We might have some others that would need it.

We are hoping that the increase in teacher pay will balance itself out in time and that we will be able to compete with industry for the people that we had been losing to them.

Mr. **Erdahl**. It seems to me that rewarding excellence in education makes good sense. I think that is a good investment. That is my personal reaction.

Obviously you have made a distinction between two types of incentives, bonuses, or stipends. One would be to attract teachers into this area that we have talked about for the last couple of days in these hearings in mathematics and science.

The other would be to reward outstanding performance. Maybe we should expect outstanding performance of all teachers. I like the idea of the reward system and have toyed with it, wondering how we could do.

I understand there are difficulties.

Dr. **Parent**. We do have a part of this act that suggests there might be a flexibility in those States that have bargaining and that there could be an arrangement where when you have a shortage, say, in the science and mathematics area, that a teacher instead of coming in on the zero step of your salary grid, they would be allowed to come in on a higher level.

This would track along with the grid. But the bonus system, I feel, would not be a very successful suggestion in Minnesota, for example.

Perhaps they could come in on the fifth step of the salary schedule.

Mr. **Erdahl**. I think it is a modification of the same concept.

Mr. Tirana, I think it is well that you are here today because we often think that we should make a linkage between what young people might learn in school and what they do when they get out of school.

Sometimes maybe we see a breakdown there and people are concerned and apprehensive with high unemployment and all the rest.

But I think what you told us today is a rather startling and terrifying indictment of how our educational processes are working in certain parts of the country.

As I take it from reading about your company it has been an innovative and expanding company. Yet you choose to move out of this area—the Washington-Virginia area; and some of us as Members of Congress have our children going to school here—because you felt there was not an adequate education here, at least in the scientific, technical, and mathematical area.

You mentioned Minnesota, the Twin Cities, as an area, and California and other parts of the country where you had found students who at least had the background that you could utilize.

Am I making an incorrect assessment of the thrust of your testimony?

Mr. **Tirana**. It is a correct assessment. But I would not say that the problem is students in an area. The problem is an overall environment.

Mr. **Erdahl**. I was not trying to imply that it was a problem with the students. Maybe you can expand on that. I am just making the assumption that the students basically are not that different. It is the educational opportunities that they have either received or been denied.

Mr. **Tirana**. That is correct.

To the extent that one looks for a skilled technician in this area is likely to have acquired his skills and his knowledge through service in the Armed Forces. He will have gotten his education there and not in school.

The advantages of California, Minnesota, the Denver region, the New England-Boston-Route 128 are that there is an overall environment that has existed for many years.

This is highly supportive of education in its broader sense. People like to go to work in that kind of environment because they have peers. These are your engineers and because their children can get an education.

There is a learning through osmosis, if you will. People are aware and alert about the opportunities. It is no wonder that an Apple computer would start in San Francisco Bay area.

The Federal Government has been a principal partner in this leadership. The Department of the Navy had a research laboratory in Minneapolis. Out of that was spawned Sperry-Univac and Control Data.

Mr. **Erdahl**. And Honeywell and 3-M.

Mr. **Tirana**. What appears to me is that there is a lack of national concern that States and school boards can follow.

How is a person supposed to go who wants to go into teaching science or teaching mathematics at any level when he sees layoffs in New York City, for instance. I guess they have laid off to the point that you have to have 12 years tenure to be assured of a job.

Anybody has to be crazy to want to go into that profession and to see the Federal Government continuing to shrink its support of education overall.

My sense is that there is an overall crisis in leadership which begins here in Washington.

Mr. **Erdahl**. That also is an indictment. I think it is one we need to hear.

It reinforces some of the alarming statistics that we have heard for the last couple of days of what other countries are doing in their educational system. We can get a Ph. D. for example, in this country, without a language. Maybe this could be without any math or science either.

We read how many years the Soviets are emphasizing, as well as the Japanese, the West Germans, and others. It does alarm me that we are going to have to have another Sputnik or some type of an international situation that shakes us out of our present mood of unconcern, at least at the Federal level, for stressing excellence in this area.

I perhaps have taken more time than I should. I will turn to my colleague from Pennsylvania, Mr. Goodling, for any comments or observations you would like to share with us.

Mr. GOODLING. Thank you, Mr. Chairman.

The first observation would be that I do not want you to get too comfortable in that chair because if we ever get a majority here and I can get Mr. Erlenborn to go into the private sector and Mr. Jeffords to run for some other office, I expect to occupy that chair. [Laughter.]

Mr. ERDAHL. I will just assure the gentleman from Pennsylvania that my concern for the next 4 weeks and 5 days is not this chair; it is just to survive an election back in Minnesota. [Laughter.]

Mr. GOODLING. I have been giving a lot of thought to what it is we are trying to accomplish in relation to the areas we are speaking about now.

It has been a couple of weeks since we have been on this particular issue and the more I think about it, the more concerned I become and the more worried I become.

I am afraid that we are going to rush into something and end up throwing more dollars at a problem in an attempt to cure it, which it has never succeeded before.

One of my major concerns is that unless we find a different approach on the elementary level in relationship to educating elementary teachers, I am not quite sure how we solve this problem.

On the other hand, Dr. Parent, I agree when you say:

"An effective solution to America's long-term productivity needs requires a strong elementary and secondary foundation. The mission of K through 12 should not be distorted to being viewed as solely one of occupational training as distinguished from educating the future citizenry."

I do not know how it is now, but when I was employing teachers, an elementary teacher probably had two courses in math and two courses in science in college.

One of those was "The Teaching Of * * *" which really was not a math course or a science course at all. It really did not do much to help them teach math or science. That much I am sure of.

Most elementary teachers are teaching math and science by relying on what it was they had in their own elementary and secondary school.

Then we got the great idea in Washington that we should encourage modern math, which was no problem to a math teacher who was trained to be a math teacher.

But can you imagine that elementary teacher out there who was relying totally on what she learned in elementary and secondary school to teach that math?

Then we gave her a couple of workshops which really confused her or him completely.

Given our past experience, I am not just quite sure how we handle this problem. I am worried that we will just throw money at the problem and think that is what is going to change things.

We had four superintendents here about a week ago. Three of them said they only needed more money. They said that would solve all the problems and to just give them money.

The other superintendent came from the District of Columbia. She did not ask us for more money. She said:

"Do not take any more away from us."

She went to great length to show how she is involving the private sector and the different businesses in this community in helping her to provide the kind of education she thinks is needed in Washington, D.C.

I am not that much interested in what they do in other countries. We have a specifically different kind of lifestyle and one that I do not want to give up for anything any other country has.

We attempt to educate everyone for at least 12 years. That is something we undertook 20 years ago. Some States that were enlighted began before that, which is entirely different from what most other countries are doing.

Do you have any suggestions of how we create an interest in a youngster to be actively involved in math and science if we do not do it on the elementary level?

Dr. PARENT. I would like to point out that there has been a perception in this country that the schools are failing to educate the children in math, for example.

What is not commonly realized is that up until the 1940's for over 200 years math had not changed. It was taught the same way in the 1940's as it was 200 years ago.

But in the time since that knowledge about math has increased twentyfold. It is not so much that the schools are not doing what they did in Grandpa's time. It is just that events have moved so fast and knowledge has increased so rapidly that it has been impossible for the schools to keep up.

We do have to start on an elementary level. So far as H.R. 7135 goes, this is one of the features of it. It is a local plan.

The local plan is devised by the school board and the citizens of that district that will fit their particular situation.

For instance, the museums—which are a delightful part of this bill—and the opportunity to use them, is there. But many, many school districts in this Nation have no accessibility to the exploratorium or to the space center, such as they have in Houston or San Francisco.

It is a matter of a field trip that is an impossible distance away.

So there have to be other situations that are developed for the children in that district.

That is why this bill has a local plan and the basis of what you do in your own district.

Mr. GOODLING. In an area such as ours, where Mr. Tirana was having trouble getting competent employees, this should be an ideal location with all the mathematicians and scientists around here.

You would have thought they would have begat some mathematicians and scientists.

We will always be faced with the drain. I said the other day when you talk about on the college level, how many outstanding professors did you sit before on the college level? Many are not interested in teaching mundane material every day in class. They want to do the research.

So you might go to a prestigious institution because you have heard about professor so-and-so. You will see his graduate assistant, but you are very lucky if you get anything more than perhaps a wave to him as he goes by to do some more research or to go speak someplace.

The problem is compounded. I realize that after World War II with the baby boom I hired people who were breathing when I was a school principal. That was the most I could say. I had to have someone who was breathing in the classroom.

Then once they are there, how do you get them out? That becomes a very difficult thing to do because you say:

"Well, OK, I have about a year or a 2-year period where I might move them out without having 742 lawsuits."

But at that time you are hiring someone who is an unknown quality that is also just breathing. You might as well keep the one hoping that you will improve them. Then they will get tenure.

So we do have those kinds of problems. Now we have a reduced birthrate, so we have an ideal time, I think, to be employing teachers at this particular time with the declining birthrate.

The biggest fight in every school district is this. I do not think the Houston example applies to this. I think they are probably still growing.

But most school districts say: "Which schools do we close?"

That is the biggest issue in the community. They say: "Don't close mine."

But I really believe we have to find some way to stimulate an enthusiasm for math and science studies on the elementary level.

I am not positively sure how you do that. I think there would be a lot of retraining in order to do that.

Mr. TIRANA. Is not the biggest problem that the committee has a political problem of the conflict between the concept of education being a local and State concern?

Yet, you have a strong national interest in making sure that our population receives math and science and foreign language training so that we can compete in 1990 and in the year 2000 with the rest of the world.

Mr. GOODLING. The problem, though, that I see is this. You cannot take those students and say:

"You are going to be math, science, and foreign language people."

The problem is: How do you stimulate them in the first place?

All that money we threw after Sputnik went up—that did not get us to the Moon. What got us to the Moon is that we went out and paid the very best there was to get us to the Moon and gave them all sorts of prestige.

That is what got us there. It was not the money we spent educating or reeducating science or math teachers.

Mr. TIRANA. But probably, Mr. Goodling, part of what got us there—the ability to find people—was that some 10 or 15 years before the NDEA had been adopted.

Many people had been able to pursue education because of national legislation.

Mr. **Goodling**. We increased that 100-fold. If that is the way you do it, then we should have more math and science teachers coming out of our ears than we know what to do with.

That whole program has been increased tremendously. When we took the cap off student loans for examples everybody and their brother—whether the income was $100,000 in the family or $1,000 family—they certainly had that opportunity. They did not worry about paying anything back. Some of them, unfortunately, do not worry about paying it back after their Ph. D.'s.

So, it is just providing more opportunities for them to go to school, I would think that we would have an awful lot of math and science teachers or trained people out there.

We have increased that tremendously.

Mr. **Tirana**. The problem is this: Is the National Legislature willing to target funds in such a manner that interfere with the discretion and independence of the State agency or the local agency? It has been unwilling to do so, and I understand why.

Mr. **Goodling**. But can you then motivate those youngsters to move in that direction? If I go back again to the point that if there is not a real desire built up on the elementary level in the area of math and science, you are not going to do it when they become junior high school and senior high school students.

I do not know how you do that. By that time many students are frustrated in math and science.

Part of it is a curriculum problem. When we started educating everyone K through 12 we, to some extent, probably did not demand as much as we may have demanded before when you had a more select group of students going to school. That probably is part of the problem.

Mr. **Tirana**. I accept that. But how can one accomplish any objective, be it at the elementary or secondary level in terms of emphasis of education, teacher selection, teacher quality, unless one interferes with State and local discretion?

There has to be a conscious choice by the National Legislature, if, for nothing else, for the economic incentives.

Mr. **Goodling**. Of course, we live in an incentive society, so there has to be some incentive. Apparently they have some incentive in Houston.

In most places there is some merit pay. You are pretty well locked in—the mediocre, the average, and the above average pretty much receive the same kind of pay.

Like everything else, we have mediocre and average and above average in education.

Ms. Van Dorn, would you like to comment?

Ms. **Van Dorn**. You struck a nerve earlier.

I was one of those elementary teachers who was put into teaching new math with two teacher workshops. So you did strike a nerve.

I used to be an elementary teacher in New York and also in Seattle. I spent 11 years at the Pacific Science Center in Seattle and until 6 months ago was director of its education programs for a number of years.

I have heard a great deal of rhetoric about our science and mathematics education problems, especially in the last year.

Probably the best forum for that discussion was at the national convocation that the National Academy of Sciences held last May.

It seems to me that it is very easy to talk about specific problems and specific ways to attack that without acknowledging that the problem is so complex that our solutions must be complex and must take a look at teacher training and must take a look at the curriculum materials that we are using.

It must consider the kinds of equipment. Are we using computers in our schools as much as we are in the museums, perhaps, that I represent?

And we should take a look at the overall learning environment of the community. I was very glad to hear that a few minutes ago, also.

I have an acquaintance in Seattle, a Japanese mother of four boys, all of whom have earned national merit scholarships. She was interviewed by the local newspaper. She was asked: "My goodness, I can understand that certainly your family is intelligent. There is some heredity involved here. How do you explain this success?" Her response, No. 1 was: "We tried to create an environment within our home that fostered educational excellence." I was glad to hear the example she gave because one of the first things she said was: "We bought a family membership to the Pacific Science Center and we got our children down there one weekend a month."

She also mentioned many other things, including getting her children exposed to jobs in local businesses and making sure that they were in programs in school that were academically sound.

She said that she also was active within her local school district in trying to insure that there were good teachers and good programs.

That kind of total commitment does not happen just because we fund an NDEA program. But that is one of the things that can help.

I appreciate the soap box for a minute to say that this happens only with national leadership, but it has to be a partnership and involves local and private support, too.

I think the challenge is great for you. All of us hope we can be of help to you.

Mr. GOODLING. I think you reenforced one of the things I said. It is a very complex problem we are dealing with. I just hope that we do not try to come up with some quick easy fix.

Quick easy fixes run out the next morning. Then you need another quick easy fix. I do not know of any quick easy fix in this particular instance.

I just have one last comment.

You talked about the Japanese family. When the first wave came from Vietnam, my teachers got all excited: "What in the world will we do? We need all these special teachers."

I said: "I have news for you. I will guarantee you that in the wave of youngsters who are coming, the incentive will be so great at home that they will bypass our youngsters in a short matter of time."

I found that even Montgomery County, Md., did an examination and discovered that No. 1, were the Vietnamese. I forget who were No. 2 and No. 3.

Nevertheless, it partly is what you are talking about. It is that incentive. Their parents knew and they knew and together they worked to make sure that the youngster did have an opportunity.

I do not know how you move from class to class or school to school, though, to make sure that you get the good teachers for a good educational program. That becomes difficult.

Mrs. **Carl**. I would like to comment on how that can work for a district.

In Houston we have some 62 languages and dialects that we are dealing with in our public schools. Many of them are Asian.

One of the ways of getting elementary youngsters involved and interested in mathematics is through mental arithmetic or number sense contests.

In recent years the names that we could not pronounce are the names of the winners. The youngsters who are of the English speaking group are now challenged by this competition.

We have seen the scores that at one time were between 50 and 100 being top scores and first prize winners now ranging in the 500's for all students.

We also have gotten teachers interested to the extent that they now are sponsoring clubs, math clubs, in their schools.

The district has taken advantage of their interest and making them facilitators, that is, onsite facilitators. In the overall structure that we are looking at for the next few years, we are hoping that these teachers with the help of others on the elementary level, are going to begin to take the places of those teachers that we have retrained now to move into the middle schools.

Those middle school assignments will relieve the secondary people who are fully qualified to teach more math in the senior high schools to get a structure of math that serves all of our children and keeps the young children in the elementary school on target and ready for middle school math and then prepared for the upgrading on the secondary level.

The State is also moving toward increasing the requirements for graduation in math and science and no longer—we are promised in the next legislature—will 1 year of math or 1 year of science be sufficient for graduation from high school.

Mr. **Erdahl**. Thank you very much for sharing that.

I could not help but think while you were talking that the two things we can probably give to our young people—whether we are teachers, administrators, school board members, or industrialists or congressmen—is encouragement and a level of expectancy.

I think oftentimes young people rise to that level.

I just have another comment as we bring the hearing to a close. I think, Mr. Tirana, as you talked about and shared your observations about this whole problem with us, it seems that a couple of things come out.

One—and again I am not trying to put words into your mouth, but I am using my own—is that it seems to me that it is in our national interest so far as a Federal policy is concerned, that we have a broad base of qualified people in these areas of science and math.

There are others as well. People rise from this to maybe the levels that they do put together, such a rocket that gets to the moon.

But it seems that this should come out of as broad a base as possible.

One of the areas that we, perhaps through stereotyping have ignored—and we are glad that Mrs. Carl is here today—is that young ladies, the girls, in school sometimes are not expected, traditionally at least, to get involved in math and science.

Here, too, I think, it is the whole question of our stereotyping of expectancy and whatnot that we try to afford these opportunities.

That should be our goal to relate to what Mr. Goodling mentioned. We surely cannot force people, we cannot slot people into these various fields, but I think we should give students a broad base of opportunities. The opportunities should be not only on the educational level, but eventually on-the-job level where they can see some potential results and rewards down the road. Rewards are not only monetary but also achievement and success and doing something they like to do.

I think the Federal Government does have a role. Just yesterday we had an argument with the Secretary of Education about Public Law 94-142, the education of all handicapped.

This is where the Federal Government properly, I think, got involved because in many areas State and local governments did not respond to some very definite needs of trying to stress not the disabilities, but the abilities of handicapped people.

I think we can look at other areas such as foreign language. I know the school boards are properly sensitive to local control and I am a strong advocate of it—but it seems like the Federal Government can have policy incentives in funding, to give a direction and to provide some challenges in these areas to respond to what are very real needs.

I think we cannot ignore what other countries are doing in science and math and what they are stressing.

Somebody mentioned here today—and I think it was Dr. Parent—that not too long ago we had 70 percent farmers 150 years ago. Now we have 3 percent.

We think of what happens in these so-called developing nations when they become more developed. In China, there are about a billion people and probably about 70 percent and maybe more are still peasant farmers—700 million.

If they turn 10 percent of them loose in industry, whether they are making textiles or computer chips, that is an awful lot of people. Other countries in Africa, South America, and others are going to be moving ahead in these same areas.

I think that we in this country are being pennywise and pound foolish as we cut back—whether it is on the Federal, State, or local level—not only the funds, but the emphasis in some of these programs that enable our young people, and we as a nation, to not only better compete, but possibly to survive economically, politically, and even militarily, in this rather complex world in which we live.

I want to thank you all for being with us today. I think you have provided some good food for thought and good testimony.

Even though some of my colleagues are absent today, your testimony goes into the record. It is available for my colleagues and staff.

Thank you very much for being here.

The subcommittee stands adjourned.

[Whereupon, at 10:50 a.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

PREPARED STATEMENT OF ROBERT L. SMITH, EXECUTIVE DIRECTOR, COUNCIL FOR AMERICAN PRIVATE EDUCATION (CAPE), WASHINGTON, D.C.

At the recent fall meeting of its Board of Directors, the Council for American Private Education (CAPE) recorded its strong interest in and support for the purposes of current legislation designed to strengthen mathematics and science education in the nation's public and private schools.

The sobering facts about the critical shortage of math and science teachers, the disturbing weakness of a sizeable majority of American students in math and science, the crucial need to train young minds to meet the evolving realities of a technological age all speak to giving a very high national priority to the improvement of all facets of math and science education.

In contributing thoughts to the formation of a national policy respecting these matters, we are mindful that the problems involve all segments of education from elementary and secondary to college.

The gloomy facts have been well documented by others for your Committee. In addition, the booklet "Science and Mathematics in the Schools: Report of a Convocation", a report recently written by the National Academy of Sciences and the National Academy of Engineering describes the varying matters at hand in a cogent, forceful and mercifully brief manner. I therefore won't try to cover this ground again except to note the underlying irony: that the mightiest industrial-technological country on earth is in grave danger of losing its preeminence because of grossly neglecting the first principle of any nation—bringing up its youth in the knowledge and skills needed for survival.

Other private school representatives will undoubtedly offer further thoughts toward maximizing the effectiveness of the proposed math-science legislation as the time gets closer for Committee consideration. At this time, however, we respectfully submit the following suggestions which we believe speak directly to the most central elements of the math-science crisis in the schools.

I. A non-legislative, no-cost prescription is that all teachers, and not just those teaching math and science, encourage at every grade level and in every way possible growing girls to not only perceive themselves as just as able to do math and science as growing boys, but consider these fields in their career plans. At least part of the talent gap is a serious gender gap.

II. Legislation should include (as H.R. 6674 seems to) provision for cooperative arrangements between all sectors in a community having an interest in improving the quality of education. Specific encouragement should be given to the development, by public and private schools, industry, and local government of technological centers or laboratories to be used by both students and adults to gain new skills and technological literacy. The equipment needed is expensive and no educational entity can bear it alone. Tax incentives should be made available to those companies which participate.

III. Funding should be made available, through the National Science Foundation, the Department of Education, or other appropriate vehicles, for establishing, on a major scale, in-service training programs for math and science teachers, public and private, with the participation and help of college teachers. The model of the Bay Area Writing Project for English Teachers, funded by NEH, would seem to be highly relevant.

IV. We strongly support the provisions of the McCurdy and Glenn bills which attempt to stimulate an infusion of new teachers into Math and Science teaching by providing low cost loans to college students pursuing math-science degrees for which payment is forgiven at the rate of 25 percent per year of teaching in elementary or secondary school. Because the effect of this provision will take many years to bear fruit, we urge that the Committee acknowledge the importance of this factor in its handling of the legislation.

V. We support efforts to create various forms of cooperation between industy and schools including the tax-deductible gift of computers, the use of appropriate industry personnel in in-service and part-time teaching roles (private schools would not insist on a teaching credential) and the summer employment of school teachers in industry. (N.B. McCurdy and Glenn Bill does not permit industry personnel to teach in private schools. We view this as a serious mistake.) In addition, we would support other efforts to make it possible for industry to make tax-deductible gifts of equipment or of corporate funds for the purpose of strengthening math-science education in schools.

VI. Because a significant pool of potential math-science teaching talent exists among senior citizens who have retired from math-science related careers or who are otherwise equipped to teach in our schools, we would urge that incentives be established for utilizing their services. Among these might be waiving the teacher credential requirement (in private schools this would be no problem) and increasing the amount of money above social security which they could earn under favorable tax conditions.

We very much hope these suggestions will be helpful to your Committee. We look forward to working with you in working out the best possible legislation to help in solving this major national educational problem.

PREPARED STATEMENT OF AMERICAN PERSONNEL AND GUIDANCE ASSOCIATION

AMERICAN DEFENSE EDUCATION ACT

The American Personnel and Guidance Association (APGA) wishes to go on record in support of, and in recognition of, the importance of current Congressional deliberations on the American Defense Education Act. ADEA and those related bills which emphasize better mathematics and science instruction in the schools, better preparation of teachers for the instruction of mathematics and science and increased emphasis on career development of students by counselors are vital in this technological age for a strong America.

The Association is confident that the Congress will give careful attention to the need for more technicians, mathematicians, scientists and engineers during the waning days of the 97th Congress and on into the 98th Congress. Any legislation dealing with the technology question must address the central role which professional counselors play in advising students in their career development, assisting teachers and administrators in curriculum improvement and creating awareness in parents and youth about the employment needs of the business, industrial and defense establishment which utilize high technology. The counselor and strengthened guidance and counseling programs provide a structure for this to occur.

To this end, the American Personnel and Guidance Association offers the following recommendations in order to enhance the impact of ADEA legislation:

1. In-service training of existing guidance practitioners, supervisors and trainers.—In-service training of counselors should emphasize the intermediary role counselors play in bringing together teachers, parents, students and the community. Counselors must be given a variety of opportunities to become familiar with the technological employment opportunities in business and industry and in the military as well as technology needs of these employers so as to better inform and advise students, teachers, administrators and parents. Hands on experiences, summer institutes, exchange programs and paid internships within industrial and military settings are some possible ways of accomplishing this goal.

The emphasis throughout any in-service program should be the counselor's role in maximizing the mathematics, science, foreign language potential of all youth, especially through early intervention programs in elementary school and continuing on through high school and college. Attention should be paid to the reduction of any job bias in counselors based on personal attitudes. Also, the in-service training should further those counseling skills and techniques which are free of any stereotypes (e.g. race, sex, culture).

In-service and re-training programs for counselors and other guidance specialists should stress skill development in non-school setting work. Examples of in-service programs might include those which develop counselor skills in working with clients, in the community or industry, experiencing job obsolescence or who need redirection of career development; those who are second careerists or returning to the work force; and those experiencing job dissatisfaction or needing advice on re-training for emerging new job clusters. This area is fertile ground for cooperative efforts between schools and industry and/or assistance from private industrial councils.

2. Pre-service training of counselors.—Encouragement and incentives must be provided to institutions of higher education, by ADEA legislation, which experiment with changes and curricular modification in the counselor education preparation programs. Internships and practicum situations which have components giving experience working in non-traditional settings (e.g. business, industry, military) must be piloted. Course work which emphasizes occupational and educational information, emerging technological and business trends should be integrated into the core curriculum preparing counselors. The creation of counselor sub-specialties for direct employment in industrial and technological settings should be encouraged legislatively. Counselors should be trained to understand emerging technology, equipment and talent/skills necessary so they may counsel, inform, and advise people for a high technology society. Experiences with computer assisted guidance, occupational information and retrieval systems and use of new methods of assessment and evaluation are essential to such training.

In addition, counselor training should have a strong component which focuses on skills in networking; in coordination of diverse groups; in consultative techniques for working with teachers, parents, administrators; and on skills and techniques for utilization of community resources.

3. Advisory Councils.—Any federal, state, local advisory or industrial council formed by ADEA legislation should include a professionally trained counselor within its membership. Such participation by professionally trained counselors is critical to the success of a turn around in the technological training and employment shortages in this country. Counselors must be fully informed of industrial needs, employment shortages and policy shifts which address the problems of the workplace. This can occur only through participation with advisory and industrial councils.

4. Research and Evaluation.—The American Defense Education Act should further and encourage (through grants, fellowships and special programs), research on new techniques, practices and programs, which increase the counselor's knowledge and skills in unlocking the potential of all youth and adults. These citizens must attain maximum personal and career fulfillment if this nation is to achieve its employment policy goals and insure national security.

More research is needed on effective data gathering, assessment, goal setting and information dissemination techniques. Research is also needed on early intervention counseling strategies with children as these concern career planning and exploration. Pilot projects on innovations in counselor educator preparation and in-service education need to be initiated which emphasize non-traditional programs, internships, practica and placements.

Evaluation devices, both periodic and long range, need to be tested to determine the efficacy of any modifications in training, re-training and practice as such concern improved counselor performance in achieving national priorities brought about by the ADEA legislation.

AMERICAN ASSOCIATION OF EDUCATIONAL SERVICE AGENCIES,
Arlington, Va., November 3, 1982.

Hon. CARL D. PERKINS,
Chairman, House Education and Labor Committee, House of Representatives, Rayburn House Office Building, Washington, D.C.

DEAR MR. PERKINS: The American Association of Educational Service Agencies submits the enclosed resolution on technology. This resolution supports the need for an appropriate training program for teachers, up-to-date equipment and curriculum to achieve.

This, in turn, will provide appropriate training programs for students which provide the key to assure that our nation remains in its leadership position.

Please use this resolution when appropriate.

Sincerely,

WALTER G. TURNER, *Executive Director.*

Enclosure.

AAESA RESOLUTIONS STATEMENT

American Public Education must keep pace with a changing world. The needs of National Defense, Health Care, Manufacturing, Communications, Business and numerous other areas of our economy, will require personnel possessing technological expertise.

Recognizing the critical shortage of appropriately prepared professional staff, and the lack of state-of-the-art equipment in our public schools, it is recommended that the American Association of Educational Service Agencies support or initiate Federal legislation which will accomplish the following:

(1) Improvement of teacher recruitment and staff development in high technology areas including mathematics and science.

(2) Access to modern equipment and supportive programs.

(3) Support for related curriculum development.

(4) Identification and encouragement of students having aptitude in high technology areas to pursue opportunities in related fields.

For the most effective impact, these vital programs should be available through the most appropriate and cost efficient delivery system.